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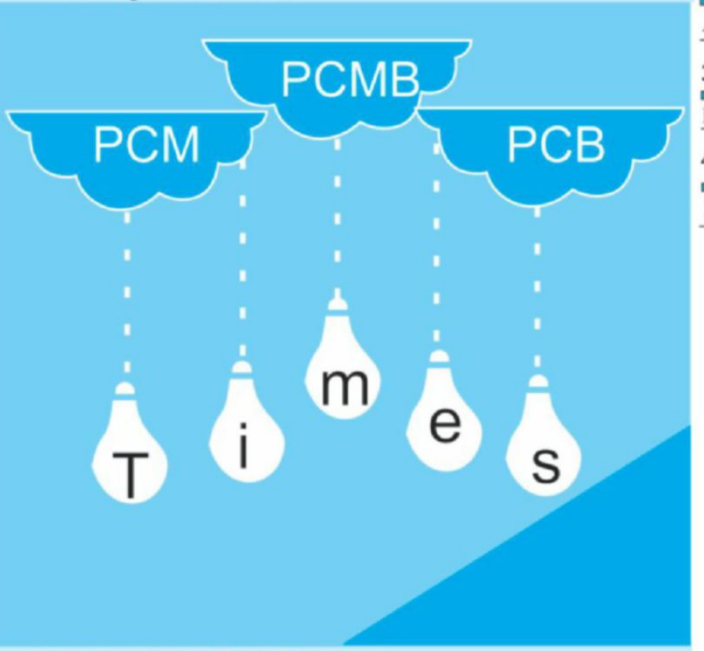

OWNED, PRINTED & PUBLISHED BY:
Eswar Reddy Alla, From Flat No:310, Fort House Apartment,
Balaji Layout, Kodigehalli, Bangalore-560092
PRINTED AT:
JAYAM PRINT SOLUTION, S.NO: 77/A, New Raja Rajeswaripet, Ajith Singh Nagar,
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NEURONS

The Lines of Communication

Concept of the month

Neural tissue and muscle tissue are considered excitable tissues because they produce electrical signals when excited. All animals except sponges use a network of nerve cells to gather information about the body's condition and the external environment, to process and integrate that information, and to issue commands to the body's muscles and glands. The nervous system, composed of neurons, is a fast communication system.

By: Murali Krishna (Hyderabad)

Structure of a Neuron

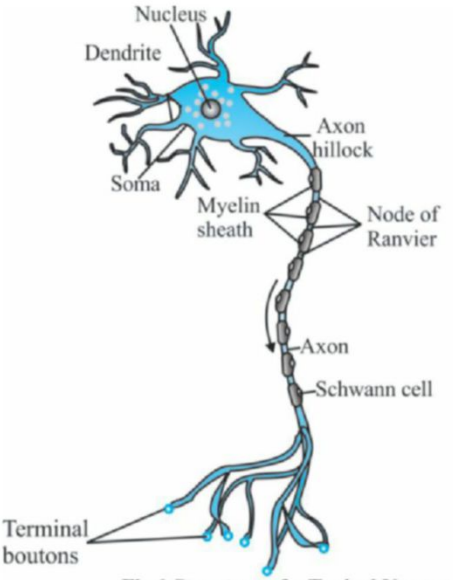


Fig.1 Structure of a Typical Neuron

Neurons are the nerve cells. A typical neuron (Fig.1) consists of a cell body and two types of processes – dendrites and axon. Most of the cell organelles, including the nucleus, are located in the ***cell body*** (also known as cyton or perikaryon or soma). A typical neuron has numerous highly branched processes called ***dendrites***. The dendrites receive signals from other neurons.

A single ***axon*** arises from a cone-shaped region of the cell body called the ***axon hillock***. The cytoplasm of an axon is called the ***axoplasm***. It is surrounded by a plasma membrane called the ***axolemma***. Axons are often much longer than dendrites. Axons of the motor neurons of the spinal cord that innervate the foot muscles may be up to one meter long. The axon is specialized in conducting nerve impulses away from the cell body to other neurons or effectors. Near its other end, an axon usually divides into many ***axon terminals*** (telodendria). The swollen tips of axon terminals are called ***synaptic end bulbs*** (terminal boutons). They contain many tiny membrane-enclosed sacs called ***synaptic vesicles*** that store a chemical called a neurotransmitter.

The site of communication between two neurons or between a neuron and an effector cell is called a ***synapse***. A neuronal synapse is generally formed by an axon terminal (presynaptic terminal), a region on the surface of dendrite of another nerve cell (postsynaptic terminal), and a thin intercellular space called the synaptic cleft. At most synapses, the pre-synaptic neuron releases a chemical neurotransmitter that

Ion channel	Description	Location	Responsible for
Leak channels	Always open or randomly alternate between open and closed positions	Dendrites, cyton, axon	Resting potentials
Voltage-gated channels	Gated channels that open in response to change in membrane potential	Axon	Action potentials
Ligand-gated channels	Open in response to a chemical stimulus (e.g neurotransmitter)	Dendrites and cytons	Graded (post-Synaptic) potentials
Mechanically gated channels	Open in response to a mechanical stimulus	Dendrites of some sensory neurons	Graded potentials

passes to the post-synaptic neuron or an effector cell.

In most neurons, the plasma membrane of the dendrites and cell body contains protein receptors that receive signals from other neurons. Therefore, the dendrites and cell body are the neuron's ***input zone***. The axon hillock is the neuron's ***trigger zone***, because it is the site where action potentials are triggered, or initiated. Functionally, the axon is the ***conducting zone*** of the neuron, as action potentials are then conducted along the axon. The axon terminals constitute its ***output zone*** because they release a neurotransmitter that stimulates other neurons or effectors cells close to them.

Ion Channels

Because the water-soluble ions responsible for carrying charge cannot penetrate the plasma membrane's lipid bilayer, these charges can cross the membrane only through specific ion channels. Ion channels are membrane proteins that form pores through the membrane, allowing diffusion of specific ions across the membrane. Various types of ion channels are listed in the above table.

Resting Membrane potential

Membrane potential is similar to the electrical potential difference that exists between the two poles of a battery. In a battery, one pole is positive, and the other is negative. Similarly, a potential difference exists across every cell's plasma membrane.The side of the membrane exposed to the cytoplasm is the negative pole, and the side exposed to the extracellular fluid is the positive pole.

Why is the cell membrane polarised?

Like all cell membranes, the plasma membrane of a neuron acts as a barrier that separates charges. As already stated, water-soluble

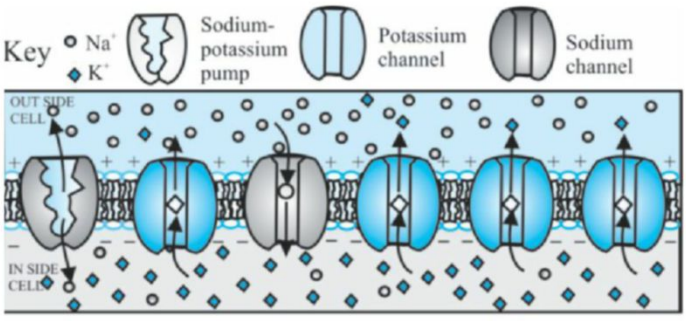


Fig. 2 Resting membrane potential

ions responsible for carrying charge cannot penetrate the plasma membrane's lipid bilayer. There is a small build up of anions in the axoplasm just inside the axolemma, and an equal build-up of cations in the ECF just outside the axolemma (Fig.2).

Such separation of positive and negative charges across the membrane is a form of potential energy. The membrane potential can be measured by a voltmeter (Fig. 3) or oscilloscope.

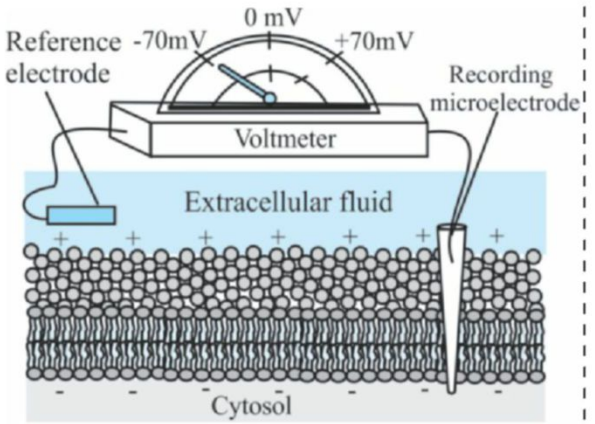


Fig.3 Measurement of the resting membrane potential of a neuron

A resting potential of –70 mV is tiny compared to the voltages used to provide electric current in a home (240 V), or even that of a battery in your TV remote (1.5-V). Nonetheless, this tiny difference in charge across the membrane of a neuron is sufficient to generate a nerve impulse, or action potential.

The resting membrane potential of a typical neuron is –70 mV (millivolts). The minus sign indicates that the inside of the cell is negative with respect to the outside. Thus, the resting membrane is polarised.

Tip: To remember the polarity of resting membrane potential, associate **N**egative with i**N**side and p**O**sitive with the **O**utside.

The membrane is said to be in a state of ***polarization*** any time membrane potential is other than 0 mV, in either the positive or the negative direction. If the inner side of the membrane changes towards positive (becomes less negative or positive), it is said to be ***depolarized***. The membrane is said to be ***repolarized***, if the membrane returns to resting potential after having been

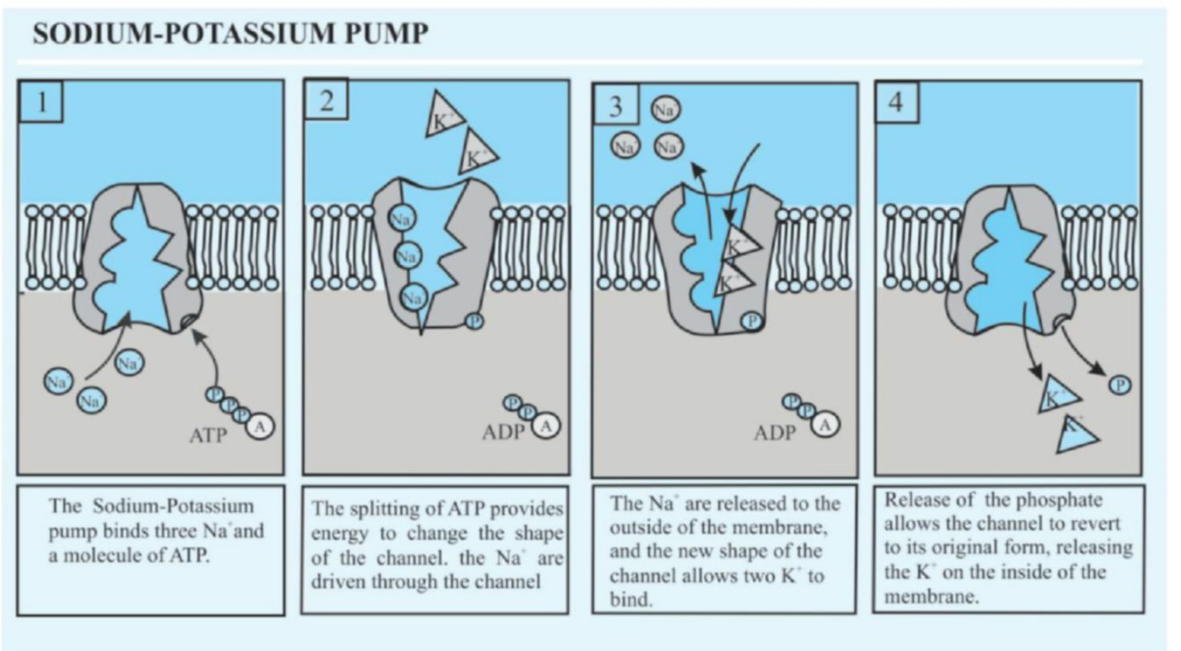


Fig.4 Sodium-Potassium Pump

depolarized. The membrane is said to be ***hyperpolarized***, if the inner side of the membrane becomes more negative than at resting potential. Depolarizations (-55 mV) bring a neuron closer to the threshold, and hyperpolarizations move the neuron further away from the threshold.

Factors that contribute to resting membrane potential

The following factors contribute to the resting membrane potential of a neuron:

Ionic gradients

There is unequal distribution of ions in the ECF and in the cytosol (axoplasm). The concentration of Na^+ in the ECF is ten times to its concentration in the axoplasm. The concentration of K^+ in the axoplasm is thirty times to its concentration in the ECF. The principal anion in the ECF is Cl^-. The principal anions in the axoplasm are phosphates (e.g. in ATP) and amino acids in proteins.

Differential permeability

The plasma membrane has more K^+ leak channels than Na^+ leak channels and K^+ leak channels are more leaky than Na^+ leak channels. This makes the resting membrane roughly 100 times more permeable to K^+ than to Na^+. Consequently, the number of K^+ ions that diffuse down their concentration gradient out of the cell into the ECF is greater than the number of Na^+ ions that diffuse down their concentration gradient from the ECF into the cell. As more and more positive ions exit, the inside of the membrane becomes increasingly negative.

Non-diffusible anions

Most anions inside the cell cannot follow K^+ out of the cell because they are attached to non-diffusible molecules such as ATP and large proteins.

Sodium-potassium pump

The sodium–potassium pump (Na^+/K^+ ATPase) imports two K^+ ions into the cell for every three Na^+ ions it pumps out of the cell (Fig.4). This helps maintain high K^+ concentration inside the cell, and high Na^+ concentration outside the cell.

Though all cells display membrane potential, nerve cells have special mechanisms for using this potential to transmit information over long distances.

Equilibrium potential

The type of equilibrium in which a chemical gradient is balanced with an electrical potential is referred to as an ***electrochemical equilibrium***. At this equilibrium, there is no net diffusion of ions across the membrane. For a cell whose membrane is permeable to only one ion, the resting membrane potential will be equal to the equilibrium potential for that ion. According to simplified Nernest equation, at 37° C:

$$E_{ion} = 62mV\left(\log\frac{[ion]outside}{[ion]inside}\right)$$

Considering that concentration of K^+ is 30 times more inside the cell and concentration of Na^+ is 10 times more in the ECF (outside the cell):

- Suppose the plasma membrane of the cell is permeable only to K^+, then
  $E_K = 62\ mV\ (\log 1/30) = -92\ mV$
- Suppose the plasma membrane of the cell is permeable only to Na^+, then
  $E_{Na} = 62\ mV\ (\log 10/1) = 62\ mV$

Actually, the axolemma (plasma membrane of the axon) at rest is permeable to both the ions but it is 100 times more permeable to K^+ than to Na^+. So, the resting membrane potential (-70 mV) is more close to E_K value (-92 mV) than to E_{Na} value (62 mV).

The membrane potential can change from its resting value when the membrane's permeability to particular ions changes.

Action Potential

The momentary change (about1millisecond) in electrical potential on the membrane of a

neuron that occurs when it is stimulated is termed ***action potential***, or ***nerve impulse*** (Fig.6). In a resting membrane, the voltage-gated sodium channels are rest (activation gate is closed and inactivation gate is open). Voltage-gated potassium channels are also closed (Fig.6-a).

When the cell is stimulated, the voltage-gated channels of K^+ open more slowly than those of Na^+. As a result, an action potential begins with an increase in the membrane's permeability to Na^+ which depolarizes the membrane, followed by an increased permeability to K^+ which repolarizes the membrane.

On an oscilloscope, depolarization is represented as an upward deflection whereas hyperpolarisation is represented by a downward deflection (Fig. 6).

Stimulation

When a stimulus depolarizes the axonal membrane, some voltage-gated sodium channels are activated (activation gate opens) allowing influx of Na^+ (Fig.6-b). This causes some depolarization which opens some more voltage-gated sodium channels allowing more influx Na^+. This positive feedback cycle (Fig.5) opens a large number of voltage-gated sodium channels rapidly once the membrane potential reaches threshold (typically -55 mV).

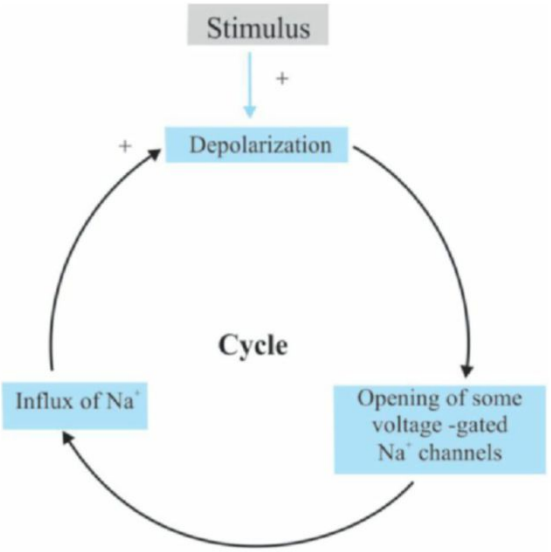


Fig.5 Positive-feedback loop responsible for opening Na^+ Channels at threshold.

At threshold potential, both chemical and electrical gradients favour influx of Na^+ (Na^+ concentration is more in the ECF than inside the cell; inside of the cell is negatively charged)

Depolarising phase (rising phase)

Rapid opening of many voltage-gated sodium channels causes rapid influx of Na^+ resulting in explosive depolarization. This changes the membrane potential from -55 to about +30mV. (Fig. 6).

During the rising phase of an action potential, the membrane potential transiently reverses.

If the level of depolarization is less than the threshold potential, the membrane potential will normally drop back to resting levels without further consequences. When the depolarization is just equal to or above the threshold potential, an action potential of equal amplitude is initiated. Thus action potential is an ***all-or-none*** phenomenon.

Firing a gun is an analogy of all-or-none phenomenon. Applying a very slight pressure on the trigger is insufficient to fire the gun. The gun fires only when adequate pressure is applied to the trigger. The speed and force of the bullet does not depend on how hard you pull the trigger. The gun either fires or it does not fire at all. In this analogy, the force applied on the trigger represents the stimulus while the firing of the gun represents action potential.

Repolarising phase (falling phase)

As membrane potential reaches its peak, the voltage-gated sodium channels are inactivated (inactivation gate closes) and voltage-gated potassium channels open (Fig 6-d). As a result, Na^+ influx slows down and K^+ efflux begins. This causes the membrane potential to

revert (return) to the resting level (-70 mV). The direction of the electrical gradient for Na^+ is reversed during the overshoot, limiting Na^+ influx.

After-hyper polarising phase (undershoot)

Voltage-gated sodium channels come to resting state (inactivation gate opens and activation gate closes) (Fig 6-e). Efflux of K^+ continues (voltage-gated potassium channels are not only slow to open but also slow to close). Consequently, the membrane potential becomes even more negative (-90mV) than it normally is at rest. The membrane potential returns to its original resting state as the voltage-gated potassium channels close.

The action potential is the entire rapid change in potential from threshold to peak and then back to resting. In a neuron, an action potential lasts for only 1 millisecond.

The Refractory Periods

The period of time after an action potential begins during which it is impossible to trigger another action potential in response to a normal threshold stimulus is called the ***refractory period***.

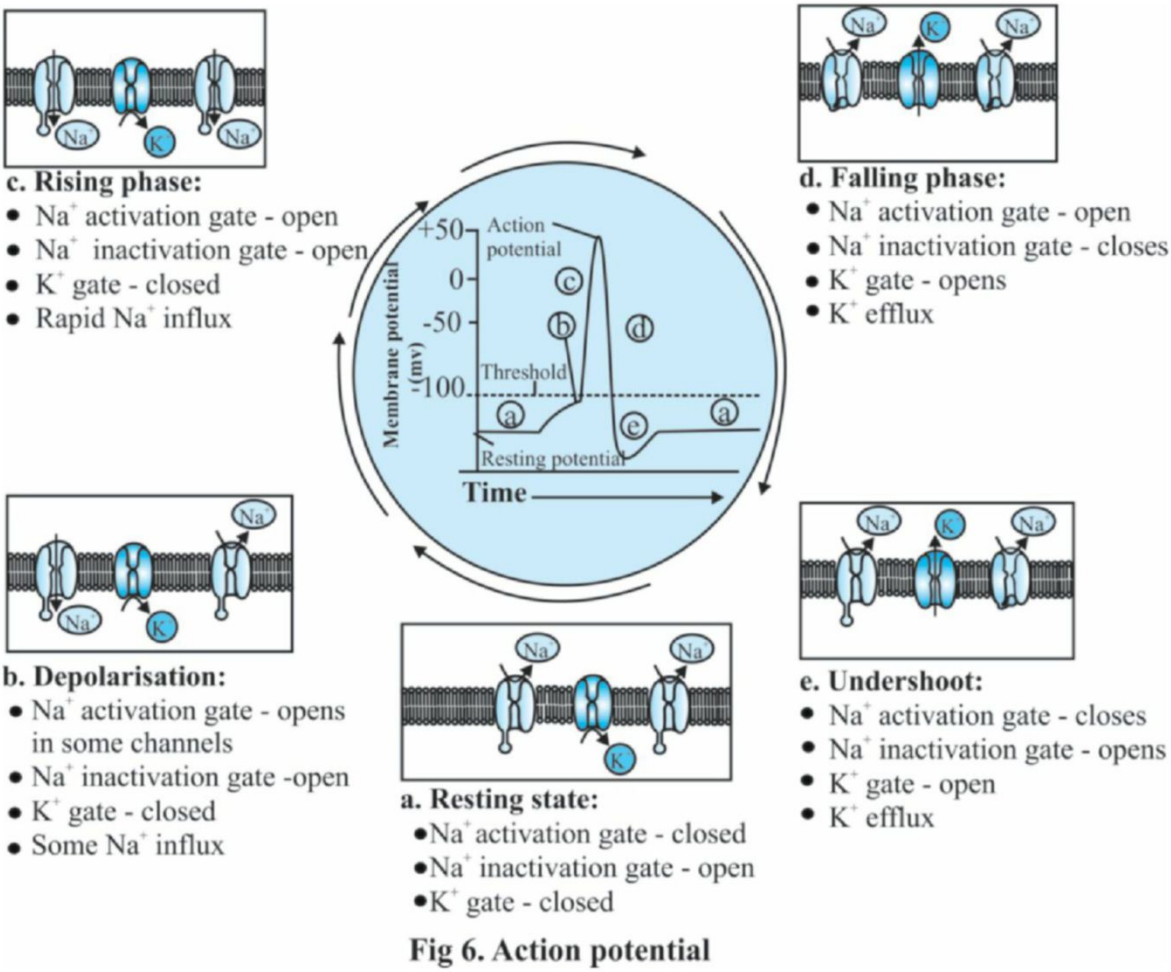


Fig 6. Action potential

During ***absolute refractory period***, even a very strong stimulus cannot trigger a second action potential. This period coincides with the period during which the voltage-gated Na^+channels are either already activated (depolarizing phase) or inactivated (repolarizing phase). They cannot be reopened unless they come to resting state.

The ***relative refractory period*** is the time during which a second action potential can

be initiated by a larger-than-normal stimulus. It coincides with the period during which the voltage-gated K^+ are open after voltage-gated sodium channels have returned to their resting state (hyperpolarizing phase). During hyperpolarizing phase, continued K^+ efflux would tend to oppose any depolarization caused by opening of voltage-gated sodium channels. This is why a larger-than-normal stimulus is needed to trigger another action potential.

The absolute refractory period is like a toilet after you have flushed and there is no water in the flush tank: Even if you push the handle, there's no discharge. Once the tank fills to half, you can flush, but it is too weak. This is like the relative refractory period. Once the tank is totally full you can get a good, effective flush once again. This is like the resting state.

Neuron as simple RC circuit

The electrical properties of neurons can be described in terms of electrical circuits.

Resistors:

A resistor is a component of a circuit that resists the flow of electrical current. As passive transporter, each ion channel can be represented as a resistor in an RC circuit.

Fig.7 symbolic represtation of a resistor

The more open channels in the membrane represent more resistors in parallel (so an overall smaller resistance).

Conductance (G) is the ease at which a particle can move through a medium. It is the reciprocal of resistance (R). Conductance increases whenever more ion channels open (e.g. due to voltage changes or binding of a neurotransmitter to a receptor of ligand-gated ion channel).

Capacitors

A capacitor is made up two conductor plates separated by an insulator (dielectric). It can store and separate a charge. In the neuron, the conducting plates are the intracellular and extracellular fluids, separated by the non-conducting lipid bilayer of the plasma membrane.

Fig.8 symbolic represtation of a capacitor

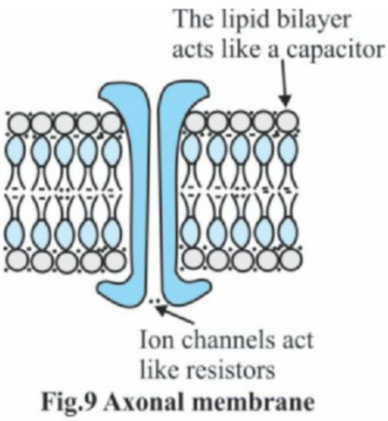


Fig.9 Axonal membrane

RC Equivalent Circuit of a Neuron

Cell membranes that contain ion channels can be modeled as an RC circuit. using a battery, resistor and a capacitor.

The ***battery*** represents the stored potential (E_K, E_{Na}) that is maintained across the cell membrane (sodium-potassium pump). ***Capacitor*** represents the intracellular and extracellular solutions, separated by the non-conducting membrane. The ***resistors*** represents the ion channels. ***Variable resistors*** represent voltage-gated ion channels as their resistance varies with voltage.

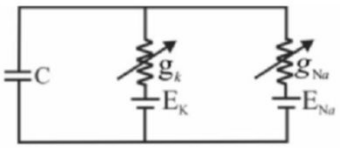


Fig. 10 Schematic representation of RC equivalent circuit of neuron

In a neuron, an action potential is triggered when more ion channels are opened (resistance is decreased and conductance is increased). This causes rapid flow of ions (current) leading to changes the potential across the cell.

In both a neuron and an electrical circuit, this voltage rises to the steady state level asymptotically in the response to an external current. Once the external current is shut off, the voltage drops in a similar asymptotic way.

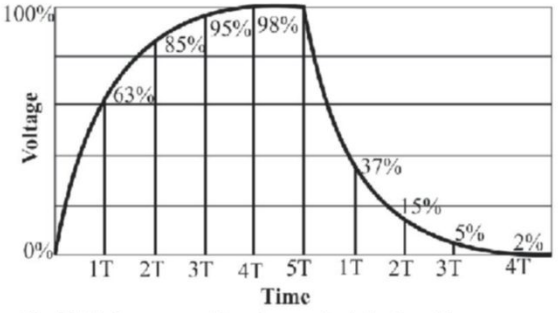
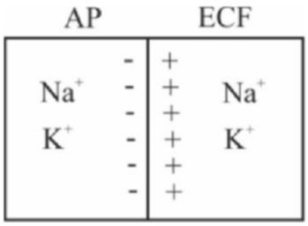


Fig.11 Voltage over time in an electrical and in a neuron

Exercise

1. The following diagram depicts extracellular fluid (ECF) and axoplasm (AP) separated by axolemma. Which of the following expression best describes the distribution of ions between the two chambers?



(a) $[Na^+]_{AP} = 10\ [Na^+]_{ECF}$
(b) $[K^+]_{ECF} = 30\ [K^+]_{AP}$
(c) $[Na^+]_{ECF} = 10\ [Na^+]_{AP}$
(d) $[K^+]_{AP} = [K^+]_{ECF}$

2. Which of the following correctly represents the permeability of the resting axonal membrane to Na^+, K^+ and proteins?
(a) Proteins < Na^+< K^+
(b) Proteins < K^+< Na^+
(c) Proteins < Na^+ = K^+
(d) K^+< Na^+< Proteins

3. Sodium-potassium pump expels
(a) Three K^+ outward for two Na^+ into the cell.
(b) Three Na^+ outward for two K^+ into the cell.
(c) Two Na^+ outward for three K^+ into the cell.
(d) Two K^+ outward for three Na^+ into the cell.

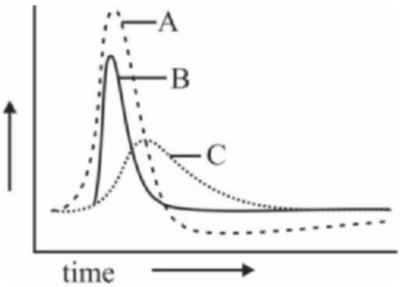
4. The most abundant extracellular cation is:
(a) Na^+ (b) K^+ (c) Ca^+ (d) H^+

5. Pick the correct option regarding the ionic gradients across the resting neuronal membrane.
(a) Axoplasm has high concentration of Na^+
(b) ECF has high concentration of proteins
(c) Axoplasm has low concentration of K^+
(d) ECF has low concentration of K^+

6. Sodium-potassium pump
(a) Is a passive transport mechanism
(b) Expels two Na^+ for every 3 K^+ imported into the cell
(c) Maintains ionic gradients across the resting membrane
(d) Triggers action potential

7. The electrical potential difference across the plasma membrane in the absence of stimuli is called
(a) Action potential
(b) Resting membrane potential
(c) Threshold potential
(d) Spike potential

8. Traces A, B and C in the given diagram depict the changes in the membrane potential (Vm) as well as changes in the membrane's permeability to Na^+ (P_{Na}) and K^+ (P_K). Select the option that correctly identifies A, B and C.



	A	B	C
(a)	V_m	P_K	P_{Na}
(b)	P_{Na}	V_m	P_K
(c)	P_K	V_m	P_{Na}
(d)	V_m	P_{Na}	P_K

9. Which of the following is not true about depolarizing phase of action potential
(a) Depolarisation occurs due to rapid influx of Na^+.
(b) The polarity of the membrane at the site of depolarisation is reversed.
(c) The outer surface of the membrane becomes negatively charged.
(d) The membrane is more permeable to K^+ and nearly impermeable to Na^+.

10. Study the following events that occur during the generation of an action potential.
(1) Hyperpolarization (2) Stimulation
(3) Repolarization (4) Depolarization
What is the correct sequence of these events?
(a) (3), (4), (2), (1) (b) (2), (3), (4), (1)
(c) (2), (4), (3), (1) (d) (2), (1), (4), (3)

11. During an action potential, repolarization of the axonal membrane is due to
(a) Influx Na^+ (b) Influx of K^+
(c) Efflux of Na^+ (d) Efflux of K^+

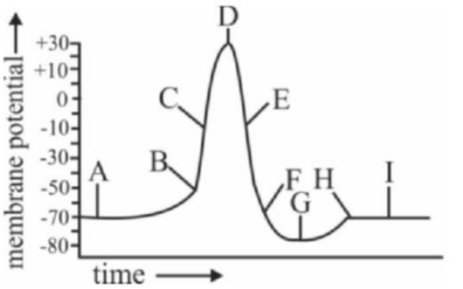
12. Each of the following is an integral part of neuron except
(a) Nissl's granule (b) Dendrite
(c) Nucleus (d) Myelin sheath

13. Which of the following is true about an action potential?
(a) The membrane to first hyperpolarizes and then depolarizes
(b) It is triggered when depolarization reaches the threshold
(c) Its amplitude varies depending on the strength of the stimulus
(d) Action potentials are generated in the dendrites and cytons

14. The ion channels in the axonal membrane are analogous to
(a) Capacitors (b) Resistors
(c) Batteries (d) Insulators

15. The movement of Na^+ and K^+ into and out of the axoplasm through channels during an action potential occurs by
(a) Simple diffusion
(b) Facilitated diffusion
(c) Primary active transport
(d) Secondary active transport

Q.Nos.(16-20) Study the following diagram depicting an action potential in a neuron and answer the questions that follow.



16. The change in membrane potential between 'B' and 'D' is primarily due to
(a) Influx of K^+ (b) Efflux of K^+
(c) Influx Na^+ (d) Efflux of Na^+

17. The membrane potential is closest to K^+ equilibrium potential at which point?
(a) A (b) G (c) D (d) F

18. What happens at the point 'D'?
(a) Voltage-gated Na^+ channels are inactivated and voltage-gated K^+ channels are activated
(b) Voltage-gated Na^+ channels are activated and voltage-gated K^+ channels are inactivated
(c) Voltage-gated Na^+ channels and voltage-gated K^+ channels are activated
(d) Voltage-gated Na^+ channels and voltage-gated K^+ channels are inactivated

19. Relative refractory period is represented by
(a) DF (b) BD (c) FH (d) BF

20. Threshold potential is represented by the point
(a) A (b) B (c) D (d) G

ANSWER KEY

1. c	**2.** a	**3.** b	**4.** a	**5.** d
6. c	**7.** b	**8.** d	**9.** d	**10.** c
11. d	**12.** d	**13.** b	**14.** b	**15.** a
16. c	**17.** b	**18.** a	**19.** c	**20.** b

Figure Arcade

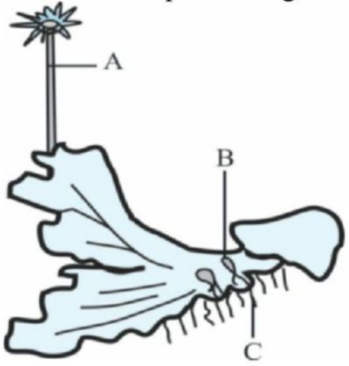
TARGET NEET

Plant Kingdom

1. Identify the structure and its respective function:

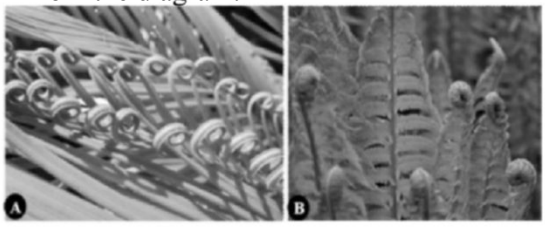
(a) Corolloid root of *cycas* for defense mechanism
(b) Corolloid root of *cycas* for nitrogen fixation
(c) Corolloid root of *ginkgo* for water uptake
(d) Corolloid root of *Pinus* for defense mechanism

2. Identify the diagram (A-D) and name the organism and its respective organs:



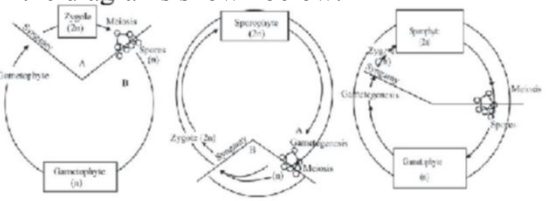
(a) Marchantia – A. Antheridiophore, B. Gemma cup, C. Rhizoids
(b) Marchantia – A. Archegoniophore, B. Gemma cup, C. Rhizoids
(c) Marchantia – A. Gemmules, B. Gemma cup, C. Rootlets
(d) Sphagnum – A. Antheridiophore, B. Gemma cup, C. Rhizoids

3. Identify the special feature of plant kingdom from the diagram:



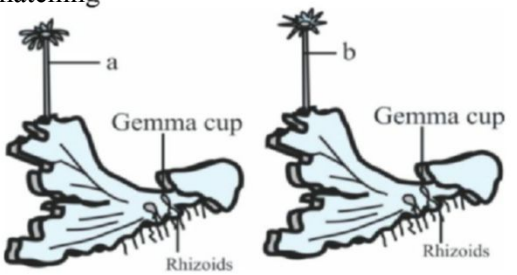
(a) Sporophyll of *Cycas* and *Fern*
(b) Circinate vernation of *Cycas* and *Fern*
(c) Capsule of *Cycas* and *Fern*
(d) Strobili of *Cycas* and *Fern*

4. Identify the life cycles of plant kingdom from the diagrams shown below:



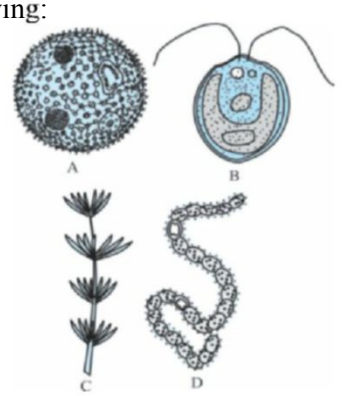
(a) Haplontic, Haplo-diplontic, Diplontic
(b) Haplontic, Diplontic, Zygotic
(c) Haplontic, Diplontic, Haplo-diplontic
(d) Haplontic, Zygotic, Diplontic

5. Recognise the figure and find out the correct matching



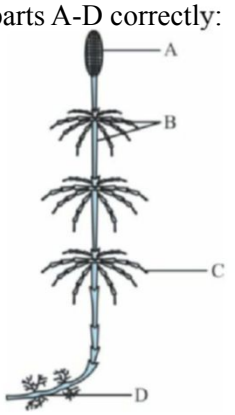
(a) a- antheridia, b- archegonia
(b) a- archegonia, b- antheridia
(c) a- archegoniophore, b-antheridiophore
(d) a- antheridophore, b- antheridiophore

6. In the diagram, identify the algae A- D, and choose the correct option among the following:



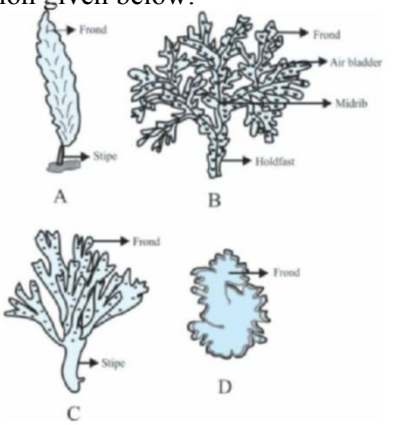
(a) A-*Nostoc*, B-*Volvox*, C-*Chara*, D-*Chlamydomonas*
(b) A-*Volvox*,B-*Chara*, C-*Nostoc*, D-*Chlamydomonas*
(c) A-*Chara*,B-*Nostoc*,C-*Volvox*, D-*Chlamydomonas*
(d) A-*Volvox*, B-*Chlamydomonas*, C-*Chara*, D-*Nostoc*

7. Examine the figure given below and identify the four parts A-D correctly:



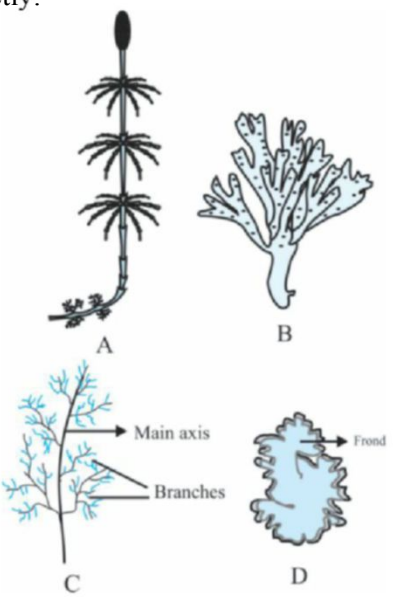
(a) A- Strobilus, B- Node and Internode, C- Branch, D- Rhizome
(b) A- Rhizome, B- Node and Internode, C- Branch, D- Strobilus
(c) A- Branch, B- Rhizome, C- Node and Internode, D- Strobilus
(d) A- Strobilus, B- Node and Internode, C- Rhizome, D- Branch

8. Identify the diagrams A-D and choose correct option given below:



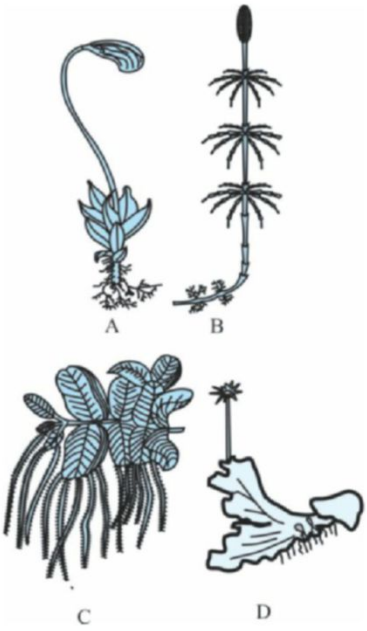
(a) A- *Laminaria*, B- *Fucus*, C- *Polysiphonia*, D- *Porphyra*
(b) A- *Fucus*, B- *Laminaria*, C- *Polysiphonia*, D- *Porphyra*
(c) A- *Porphyra*, B- *Laminaria*, C- *Polysiphonia*, D- *Fucus*
(d) A- *Laminaria*, B- *Fucus*, C- *Dictyota*, D- *Porphyra*

9. Examine the figures given below A-D correctly:



(a) A- *Chlamydomanas*, B- *Dictyota*, C- *Polysiphonia*, D- *Laminaria*
(b) A- *Selaginella*, B- *Dictyota*, C- *Polysiphonia*, D- *Porphyra*
(c) A- *Equisetum*, B- *Dictyota*, C- *Polysiphonia*, D- *Porphyra*
(d) A- *Equisetum*, B- *Marchantia*, C- *Marsilea*, D- *Laminaria*

10. Identify different plants in the figure A-D given below:



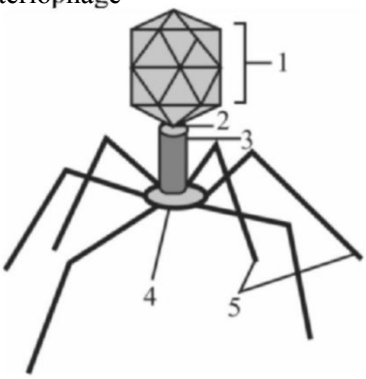
(a) A- *Selaginella*, B- *Marsilea*, C- *Salvinia*, D- *Funaria*
(b) A- *Selaginella*, B- *Marsilea*, C- *Salvinia*, D- *Chara*
(c) A- *Selaginella*, B- *Equisetum*, C- *Salvinia*, D- *Funaria*
(d) A- *Salvinia*, B- *Equisetum*, C- *Salvinia*, D- *Funaria*

11. What you know about this plant

i. It is a moss plant
ii. It is used as packing material in transshipment of live specimens
iii. It is dioecious plant
iv. It has peristomial teeth
(a) i, ii, iii, iv are correct
(b) iii only incorrect
(c) iii and iv are incorrect
(d) ii, iii and iv are incorrect

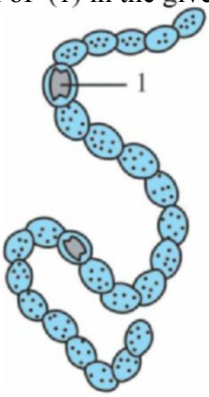
Biological classification

1. Identify 1,2,3,4 and 5 in the given diagram of Bacteriophage



(a) 1- head, 2- core, 3- sheath, 4-baseplate, 5- tail fibres
(b) 1- head, 2-collar, 3-sheath, 4- baseplate, 5-tail fibres
(c) 1- head, 2- core, 3- collar, 4- baseplate, 5-tail fibres
(d) 1- head, 2- sheath, 3- collar, 4-baseplate, 5-tail fibres

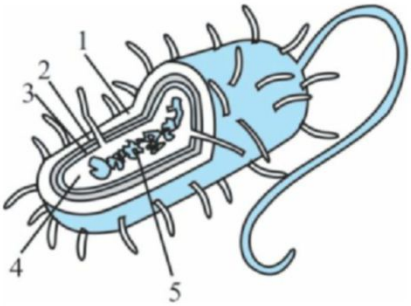
2. Function of (1) in the given diagram is



(a) Excretion
(b) Respiration

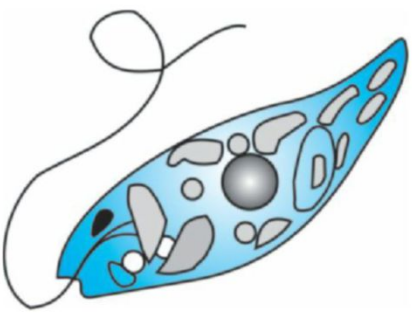
(c) Fixing atmospheric nitrogen
(d) Repoduction

3. Identify 1, 2,3, 4 and 5 in the given diagram



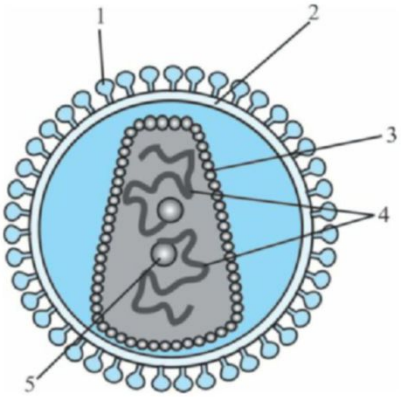
(a) 1- Cell wall, 2- cell membrane, 3- Capsule, 4- Ribosome, 5- Chromosomal DNA
(b) 1- Capsule, 2-cell wall, 3- cell membrane, 4- Ribosome, 5- Chromosomal DNA
(c) 1- Capsule, 2- Cell membrane, 3- Cell wall, 4- Ribosome, 5 - Chromosomal DNA
(d) 1- Capsule, 2- Cell membrane, 3- Cell wall, 4 - Chromosomal DNA, 5- Ribosome

4. Identify the **incorrect** statement w.r.t. the organism given below



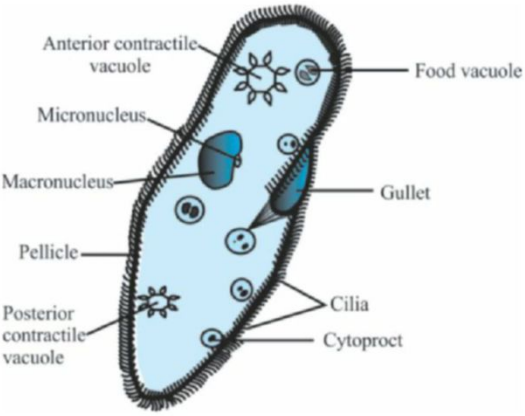
(a) Instead of cell wall, they have a protein rich layer pellicle.
(b) They have two flagella, a long and a short.
(c) In the presence of light they are photosynthetic but in the absence of sunlight they behave like heterotrophs.
(d) Majority of them are marine.

5. Identify the virus and parts namely 1, 2, 3, 4 and 5



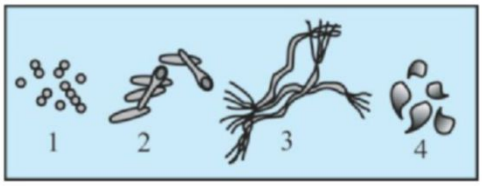
(a) TMV, 1-Capsid, 2- protein coat, 3- envelope, 4- DNA, 5- Reverse transcriptase
(b) HIV, 1- Glycoprotein, 2- envelope, 3-capsid, 4-RNA, 5- Reverse transcriptase
(c) HIV, 1-Capsid, 2- protein coat, 3- envelope, 4-RNA, 5- Reverse transcriptase
(d) HIV, 1-Capsid, 2-envelope, 3-Glycoprotein, 4-RNA, 5- Reverse transcriptase

6. Identify the correct statement w.r.t the given diagram



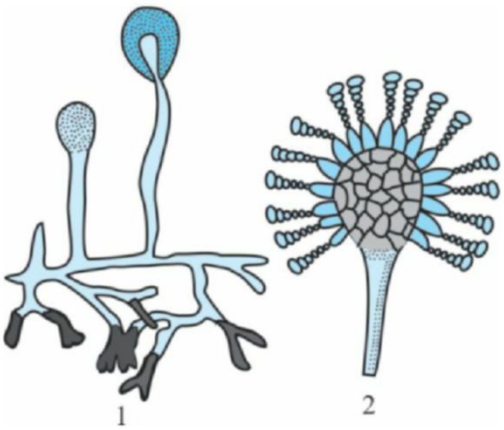
(a) *Paramaecium* are both aquatic and terrestial.
(b) Cilia are helpful for *Paramecium* both in locomation and also in reproduction.
(c) *Paramecium* has a cavity that opens to the outside of the cell surface.
(d) Cilia are not locomotary in function instead helpful only in reproduction.

7. Identify 1,2,3 and 4 from the given diagram



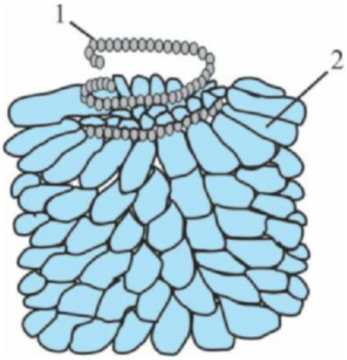
(a) 1-Cocci, 2-Spirilla, 3-Bacilli, 4-Vibrio
(b) 1-Bacilli, 2-Spirilla, 3-Vibrio, 4- Cocci
(c) 1-Bacilli, 2-Vibrio, 3-Cocci, 3-Spirilla
(d) 1- Cocci, 2-Bacilli, 3-Spirilla, 4-Vibrio

8. Identify the organisms in the figure 1 and 2



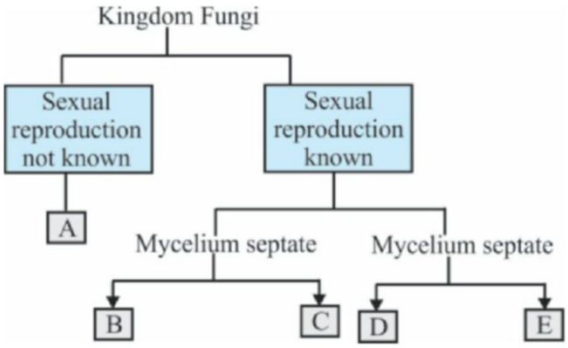
(a) 1- *Penicillium*, 2- *Mucor*
(b) 1- *Aspergillus*, 2- *Rhizopus*
(c) 1- *Mucor*, 2- *Aspergillus*
(d) 1- *Mucor*, 2- *Penicillium*

9. Identify 1 and 2 in the given diagram of TMV



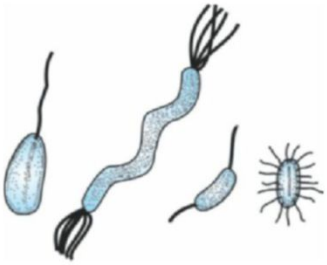
(a) 1- RNA, 2- Capsomere
(b) 1- DNA, 2- Capsid
(c) 1- Protein coat, 2- RNA
(d) 1- DNA, 2- Capsomere

10. Study the given classification table of fungi.



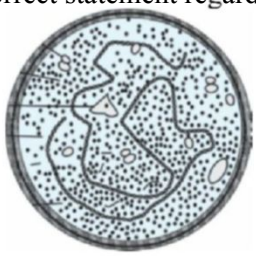
(a) In E, clamp connections occur between adjacent cells whereas, in D clamp connections do not occur.
(b) In A, sexual reproduction occurs by gametangial contact in which the male sex organ transfers its products into oogonium through a fertilisation tube.
(c) In B, zygospore gives rise to new mycelium directly.
(d) In C, the mode of asexual reproduction is through the formation of motile conidia.

11. IdentifyA, B, Cand D on the basis of flagellation and select the incorrect statement



(a) A is nitrifying bacteria
(b) B causes cholera
(c) C is used in retting of fibres...
(d) D is the source of lactic acid.

12. Refer to the given figure and identify the incorrect statement regarding it



(a) The cell membrane is made up of protein and lipid.

(b) It is resistant to wall attacking antibiotics such as penicillin.
(c) It is pleomorphic and varies in shape from spherical to branched filamentous structure and is called 'joker of the plant kingdom.'
(d) It is unicellular, non-motile gram +ve prokaryote which lacks a distinct cell wall.

ANSWER KEY

Plant Kingdom

1. b	2. b	3. b	4. c	5. c
6. d	7. a	8. d	9. c	10. c
11. b				

Biological classification

1. a	2. c	3. b	4. d	5. b
6. c	7. d	8. c	9. a	10. a
11. d	12. d			

HINTS & SOLUTIONS

Plant Kingdom

1. **(b)** Coralloid roots of *Cycas*. It contains symbiotic cyanobacteria, which fix nitrogen and in association with root tissues produce beneficial aminoacids Asparagine and Citrulline.
2. **(b)** It is *Marchantia*, a bryophyte. A, B, C are identified as Archegoniophore, gemma cup and Rhizoids.
3. **(b)** A-Circinate vernation in the compound leaves of cycads, B-Circinate vernation is the manner in which fern frond emerges, it is tightly curled so that tender growing tip of the frond is protected within a coil.
4. **(c)** The following diagram represents Haplontic, Diplontic, Haplo-diplontic life cycles in plant kingdom.
5. **(c)**
6. **(d)** In the diagram A-*Volvox*, B-*Chlamydomonas*, C- *Chara*, D- *Nostoc*
7. **(a)** A- Strobilus, B- Node and Internode, C- Branch, D- Rhizome
8. **(d)** A- *Laminaria*, B- *Fucus*, C- *Dictyota*, D- *Porphyra*
9. **(c)** A- *Equisetum*, B- *Dictyota*, C- *Polysiphonia*, D- *Porphyra*
10. **(c)** A- *Selaginella*, B- *Equisetum*, C- *Salvinia*, D- *Funaria*
11. **(b)** The diagram is related to *Sphagnum* which is monoecious and belongs to mosses and used as packing material for transshipment of live specimens
12. **(d)**

(NES) .....A competitive edge for cracking NEET

NEET Edge Series

MOLECULAR BASIS OF INHERITANCE

1. tRNA has two unequal free arms ....
   (a) Short arm ending in -A and long arm in -ACC
   (b) Short arm ending in -G and long arm in -CCA
   (c) Short arm ending in -G and long arm in -CGA
   (d) Short arm ending in C and long arm in -GCA
2. Purine possess nitrogen at
   (a) 1, 2, 4 and 6 positions
   (b) 1, 3, 5 and 7 positions
   (c) 1, 3, 7 and 9 positions
   (d) 1, 2, 6 nad 8 positions
3. If a DNA segment consists of 210 nucleotide pairs, what will be the number of nucleotides and amino acids in mRNA transcribed from it and in the polypeptide chain translated by it respectively?
   (a) 70 and 210 (b) 210 and 70
   (c) 70 and 70 (d) 210 and 210
4. 1.7 m double helical DNA will have base pairs ....
   (a) 3.4×10^9 (b) 1.7×10^5
   (c) 1.7×10^9 (d) 5×10^9
5. In a diploid organism with 30,000 bases haploid genome contains 23% A residues. What is the number of G residues in the genome?
   (a) 16000 (b) 16200 (c) 14500 (d) 8100
6. Read (i) to (v) and find the correct option
   i. Nitrogen base is linked to pentose sugar through N-glycosidic linkage
   ii. Phosphate group is linked to 5' - OH of a nucleoside through phosphoester linkage
   iii. Two nucleosides are linked through $3' \rightarrow 5'$ N-glycosidic linkage
   iv. Negatively charged DNA is wrapped around to form nucleosome
   v. Chromatin that is more densely packed and stains dark is called euchromatin
   (a) i alone is wrong
   (b) iv alone is wrong
   (c) iii and v are wrong
   (d) i, ii, iii wrong
7. In which of the following will DNA melt at the lowest temperature ...
   (a) 5' -AATAAAGC -3' 3' -TTATTTCG -5'
   (b) 5' -AATGCTGC -3' 3' -TTACGACG -5'
   (c) 5' -ATGCTGAT -3' 3' -TACGACTA -5'
   (d) 5' -GCATAGCT -3' 3' -CGTATCGA -5'
8. Who wrote "It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material" ...
   (a) Watson and Crick
   (b) Beadle and Tatum
   (c) Meselson and Stahl
   (d) Nirenberg and Ochoa
9. Which of the following statements about the Hershey-Chase experiment is false?

(a) The purpose of the blender is to detach viruses from the bacteria
(b) Progeny generations of T2 bacteriophage contained ^{32}P but no ^{35}S
(c) Sulfur is present in protein, but not in DNA; phosphorus is present in DNA, but not in protein
(d) The ^{32}P will end up in the supernatent after centrifugation

10. In DNA segment of six coils, 22 bp are linked by two hydrogen bonds. How many cytosine bases would be present..
(a) 22 (b) 38 (c) 64 (d) 76

11. Read statement A - D
i. In transcription adenosine pairs with uracil
ii. Regulation of lac operon by repressor is positive regulation
iii. Human genome has appoximate 50,000 genes
iv. Haemophilia is sex-linked recessive disease.
How many of the above statements are correct ...
(a) 2 (b) 3 (c) 4 (d) 1

12. Read the following statements and find out the incorrect statement.
i. The length of DNA is usually defined as number of nucleotides or base pairs present in it.
ii. In DNA, every nucleotide residue has an addition -OH group present at 2′ position in the deoxyribose.
iii. Nuclein was discovered and named by in Meischer 1969.
iv. Adenine pair with Thymine and Guanine with Cytosine through H-bonds.
This makes one strand complementary to the other.
v. The position of double helical model of DNA was also based on the observation of Erwin Charagaff.
(a) ii, iii and v (b) ii, iii and iv
(c) ii and iii only (d) iii and v only

13. Satellite DNA is important because it
(a) Shows high degree of polymorphism in population and also the same degree of polymorphism in an individual, which is heritable from partent to children.
(b) Codes for proteins needed in cell cycle.
(c) Codes for enzymes needed for DNA replication.
(d) Does not code for proteins and is same in all members of the population.

14. Choose the correct statement
(a) Haploid content of human DNA is $4.6x10^6$bp
(b) A nitrogenous base is linked to pentose sugar through phosphodiester linkage
(c) X-ray diffraction data of Maurice Wilkins and Rosalind Franklin was the basis of Watson and Cricks model.
(d) DNA as an acidic substance was first identified by Watson and Crick

15. Find out the correct answers out of the following discoveries ...
i. Griffith - transformation
ii. Gamow - triplet code
iii. Miescher - Nuclein
(a) i and ii correct, iii false
(b) i correct, ii and iii false
(c) i and iii correct, ii false
(d) i, ii and iii correct

16. Escherichia coli fully labelled with ^{14}N medium. The two strands of DNA molecule of the first generation bacteria have ....
(a) Different density and do not resemble parent DNA
(b) Different density but resemble parent DNA
(c) Same density and resemble parent DNA
(d) Same density but do not resemble parent DNA

17. DNA replication in eukaryotes commences ....

(a) From both ends of chromosome simultaneously
(b) Several sites along DNA of a chromosome simulatneously
(c) From one end of chromosome to the other
(d) From centromere to either end

18. Which of the following statements is correct?
i. The biochemical nature of genetic material was not defined from the experiments conducted by Griffith.
ii. Working on transformation Avery et al concluded DNA is genetic material but not all biologists were convinced.
iii. RNA is the genetic material in TMv, QB bacteriophage etc.
iv. DNA is the predominant genetic material while RNA performs dynamic functions of messenger and adapter.
v. Viruses having DNA genome and having shorter life span mutate and evolve faster.
(a) iii and iv (b) All except v
(c) i and ii (d) All

19. DNA segment, 3' TAC ATG GCT CCG 5', transcribes one mRNA. Four tRNAs with anticodons
i. AUG ii. UAC
iii. CCG and
iv. GCU are required for translation. What is the order of tRNAs ....
(a) i, ii, iv, iii (b) ii, i, iv, iii
(c) i, ii, iii, iv (d) ii, i, iii, iv

20. Select the correct statements-
i. In eukaryotes, RNA pol III catalyes the synthesis of 5SrRNA, tRNA and SnRNA
ii. DNA generally acts as a template for the synthesis of DNA and RNA
iii. During protein synthesis, amino acid gets attached to tRNA with the help of aminoacyl synthetase, ATP is also used.
iv. The first amino acid in any polypeptide chain of prokaryote is always formylated methionine but in eukaryotes it is methionine.
v. A single anticodon can recognize more than one codon of m-RNA. Thus phenomenon is termed as Wobble hypothesis.
(a) ii and iii are correct
(b) i and ii are correct
(c) iv and v are correct
(d) All are correct

21. Strand of DNA that functions as template for mRNA transcription is .
i. Coding strand
ii. Non-coding strand
iii. Sense strand
iv. Antisense strand the correct answer is ..
(a) i and iii (b) ii and iii
(c) ii and i (d) ii and iv

22. What is added to the 3'-end of many eukaryots t-RNAs during post transcriptional processing?
(a) Amino acid
(b) Trinucleotide CCA
(c) 7 methyl GTP
(d) Poly 'A' tail

23. The ratio between purines and pyrimidines in the starting codon
(a) 2:1 (b) 1:1 (c) 1:2 (d) 3:1

24. Select the Correct statement ...
i. RNA polymerase I transcribesrRNA
ii. RNA polymerase II transcribes snRNA
iii. RNA polymerase III transcribes hnRNA
iv. RNA polymerase II transcribes hnRNA
(a) i and iv are correct
(b) ii and iii are correct
(c) i and ii are correct
(d) i, ii and iv are correct

25. Part of DNA Polymerase I-enzyme after removal of 5'----3' Exonuclease activity exhibiting structural domain is called
(a) Okazaki fragment
(b) Template Strand
(c) Klenow fragment
(d) Replication bubble

26. Synthesis of all Polypeptides encoded by nuclear genes begins in
(a) Cytosol (b) Nucleus
(c) Mitochondria (d) Golgicomplex

27. In Contract to DNA Polymerase, RNA Polymerase
(a) Synthesis RNA primer of intiate DNA synthesis
(b) Fills the gap between Okazaki fragment
(c) Catalyses new strand in $5' \rightarrow 3'$ direction
(d) Checks & edits simultaneously during synthesis

28. An eukaryotic cell, post transcription prepares itself for synthesis of proteins, so as to meet its metabolic needs. The modified mRNA translates into proteins through a sequential stepwise process. Identify the correct sequence of steps in translation and select the correct option.
i. Amino acylation of tRNA
ii. Attachment of larger subunit of ribosome to mRNA-tRNA complex.
iii. Linking of adjacent amino acid to form a polypeptide
iv. Codon anticodon reaction between RNA and amino acyl tRNA complex
v. Attachment of mRNA with smaller subunit of ribosome
(a) i → ii → v → iv → iii
(b) ii →iii → i → iv → v
(c) i → v → iv → ii → iii
(d) ii → iv → v → i → iii

29. Catabolite repression of lac operon in E.coli occurs in presence of
(a) Glucose (b) Lactose
(c) Allolactose
(d) Glucose k Lactose

30. Nirenberg synthesised an RNA having 34 adenine residues (AAAA...) and obtained a polypeptide of 11 lysine residues. it proved that genetic code of lysine is
(a) Adenine (b) AA
(c) AAA (d) AAAA ....A.

31. Read the sequence of the nucleotides in the given segment of mRNA and the respective amino acid sequence in the polypeptide chain.
mRNA

Polypeptide Met Phe val Ser

i. Triplet bases (codons) for (a) Valine (b) Proline
ii. Nucleotide sequence of the DNA strand from which this mRNA was transcribed
iii. Last codon of this RNA stands for
The correct answer to the question i, ii and iii are
(a) i. Valine, GGU proline, CCU. ii. TAC AAA TAC GGA CAAAGAATT. iii. Stop.
(b) i. Valine, GUU Proline, CCU. ii. TAC AAA TAC GGA CAAAGAAT. iii. Stop.
(c) i. Valine, GUU Proline, CCU. ii. ATG TTT ATG CCT GTT TCT TAA. iii. Stop.
(d) i. Valine, GUU Proline, CCC. ii. TAC AAA TAC GGA CAAAGAATT. iii. Stop.

32. 3'-AAATGCGCGATA-5' sequence of gene will have mRNA and anticodons
(a) 5' - UAU CGC GCAUUU-3' / 3'-AUU, GCG,CGU,AAA-5'
(b) 5'-UUUACCTUGUAU-3' / 3'-AAA,UGG, UAC,AUA-5'
(c) 5'-UAUGUTCCAUUU-3' / 3'-AUA, CAU, GGU, AAA -5'
(d) 5'-UUU ACGCGCUAU-3' / 3'-AAAUGC GCG AUA-5'

33. From bacteria to men, a near universal code for phenylalanine is ...
(a) UUU (b) UUA
(c) UUG (d) CUU

34. In protein synthesis, a ploypeptide of five amino acids is synthesized which one of the following can be the correct poplypeptide?

(a) Glycine-valine-methionine-histidine-lysine
(b) Lysine-methionine valine-glycine
(c) Methionine-lysine-glycine-valine-histidine
(d) Valine-methionine-glycine-histidine-lysine

35. A segment of DNA has the triplet base sequence. AAG, GAC, AGC, CGC, ACA and AAA. Due to mutation the first base only got deleted. Then the likely effect of this on the coding of DNA segment is that
(a) There will be complete change in the types and sequence of amino acids
(b) Polypeptide will have one amino acid less
(c) There will be no change in polypeptide chain formed
(d) The first amino acid will be different

36. How many ATP & GTP molecules are respectively used for each amino acid incorporated in peptide chain?
(a) 2 & 1 (b) 1 & 2
(c) 2 & 2 (d) 3 & 3

37. Which is not correct?
(a) UGG codes for tryptophan
(b) UAA codes for lysine
(c) Cysteine is coded by UGU & UGC
(d) Tyrosine is coded by UAU & UAC

38. A coding sequence made of alternating C and U bases would form a polypeptide having ....
(a) Either leu or ser residue
(b) Alterating leu and ser residues
(c) Only ser residues
(d) Only leu residues

39. During translation initiation in prokaryotes GTP is required for ..
(a) Association of 30S-mRNA with formyl-met-tRNA
(b) Binding of 30 S subunit of ribosome with mRNA
(c) Formation of formyl-met-tRNA
(d) Association of 50 S subunit of ribosome with initiation complex

40. The correct order of events for synthesis of the lagging strand is
(a) Primase adds primer, DNA polymerase I removes the primer, DNA polymerase extends the segment, the ligases seals the gap.
(b) primase adds RNA primer, DNA polymerase III creates a stretch, DNA polymerase I removes the primer, and ligase seals the gaps.
(c) Helicase unwinds the DNA, primase creates a primer, DNA polymerase I elongates the stretch, DNA polymerase III removes the primer, and ligase seals the gaps in the DNA.
(d) Ligase adds bases to the primase,the primase generates the polymerase I, polymerase III adds to the stretch, helicase winds the DNA.

41. There are 125 Amino acids, we want to synthesis an 'mRNA'. How many nitrogen bases are required to form sufficient codon to code 125 Amino acids?
(a) 375 (b) 125 (c) 42 (d) 3

42. Which is correct ...
(a) Introns are present in mRNA and exons in tRNA
(b) Codons are present in mRNA and anticodons in tRNA
(c) Every intron is a set of three terminator codons
(d) Exons are present in eukaryotes and introns in prokaryotes

43. Escherichia coli with completely radioactive DNA was allowed to replicate in non-radioactive medium for two generations. percentage of bacteria with radioactive DNA is ...
(a) 100% (b) 50% (c) 25% (d) 12.5%

44. Find the number of phosphodiester bonds and glycosidic linkages associated with E. coli DNA respectively-
(a) 4.6×10^{6}-2,4.6×10^{6}-2
(b) 9.2×10^{6}- 2,9.2×10^{6}-2

(c) 9.2×10^{6}-2,9.2×10^{6}
(d) 4.6×10^{6}-2,4.6×10^{6}

45. In regulation of gene expression in prokaryotes
i. Lactose acts as suppressor for gene expression.
ii. Tryptophan is inducer.
iii. Regulator gene produces repressor ...
(a) i alone is correct (b) ii alone is correct
(c) iii alone is correct
(d) ii and iii are coorect

46. Read the statement regarding the lac operon and choose the correct option
i. An inducer regulates the switching on and off the lac operon
ii. Repressor protein dissociated from operator region and prevents RNA polymerase from transcribing the operon.
iii. In the presence of lactose, the repressor is activated by interaction with lactose.
iv. RNA polymerase has access to the promoter and transcription proceeds only when the repressor is inactivated.
(a) i and ii alone are correct
(b) ii alone is correct
(c) iii and iv alone are correct
(d) i and iv alone are correct

47. Select the correct sequences of steps in DNA finger printing involving Southern blot hybridization using radiolabeled VNTR as probes.
i. Hybridization using labelled VNTR probe
ii. Isolation of DNA
iii. Transferring (Blotting) of separated DNA fragments to synthetic membranes, such as nitrocellulose or nylon.
iv. Detection of hybridization DNA fragments by autoradiography.
v. Separation of DNA fragments by electrophoresis
vi. Digestion of DNA by restriction endonucleases
(a) i, v, vi, ii, iii and iv
(b) v, i, vi, iii, iv and ii
(c) ii, vi, v, iii, i and iv
(d) ii, i, v, vi, iv and iii

48. DNA fingerprinting works because-
(a) There are mutiple alleles for some DNA sequences, making it possible to obtain unique patterns for each individual
(b) DNA in the skin cells is very diverse
(c) Genes containing the same alleles make it simple to compare different individuals
(d) PCR allows amplification of proteins from single cells

49. A mixture containing DNA fragments A,B,C and D with molecular weights of A+B=C, A>B and D>C, was subjected to agarose gel electrophoriesis. The positions of these frangments from cathode to anode sides of the get would be-
(a) C, B, A, D (b) B, A, D, C
(c) B, A, C, D (d) A, B, C, D

50. The probability of occurrence of DNA polymorphism in non-coding region is more because
(a) It is beneficial to human beings
(b) It may not have any immediate effect on individuals' reproductive ability
(c) It is not always inheritable
(d) None of these

51. Initially, it was believed that the human genome has 100,000 gene. But the declaration of human genome project has shown that the number of genes in human genome is approximately
(a) 20,000 (b) 50,000
(c) 60,000 (d) 70,000

52. During chromosome DNA replication, the following events occur
i. Breaking of H bonds between bases.
ii. Bonds between adjacent nucleotide form.
iii. Winding brings about formation of two double helices.

iv. Bases on free nucleotides bond with bases on DNA strands.

Which of the following shows the correct sequence?

(a) i, iv, ii, iii (b) i, ii, iii, iv
(c) iv, ii, iii, i (d) i, ii, iv, iii

53. cDNA is copied from mRNA molecule with the help of
(a) Restriction enzyme
(b) Reverse transcriptase
(c) DNA polymerase
(d) Adenosine deaminose

54. The number of punctuation codon in a genetic code are
(a) 2+3=5 (b) 1+3=4
(c) 1+1=2 (d) 3

55. Match the following:

A. t-RNA	1. linking of amino-acids
B. m-RNA	2. Transfer og genetic information
C. r-RNA	3. Nucleolar organising region
D. Peptidyl	4. Transfer of amino acid from transferase cytoplasm of ribosome

(a) A-4, B-2, C-3, D-1
(b) A-1, B-4, C-3, D-2
(c) A-1, B-2, C-3, D-4
(d) A-1, B-3, C-2, D-4

56. DNA polymerisation rate of DNA polymerase and estimated number of gene in Human being respectively?
(a) 25000 and 3×10^{9}
(b) 2000 bp/sec and 25000
(c) 3000 and 5386
(d) 4.6×10^{9} and 2000 bp/sec

57. In a 3.2 Kbp long piece of DNA, 820 adenine bases were found. What would be the number of cytosine bases?
(a) 1560 (b)780 (c) 1480 (d)740

58. If 100 heavy DNA 15N are replicated there times in medium , the result obtained is
(a) 12.5% intermediate and 87.5% light DNA
(b) 25% intermediate and 75% light DNA
(c) 50% heavy and 50% light DNA
(d) 37.5% half heavy and 62.5 heavy DNA

59. Read the following statements and choose the correct option.
i. RNA polymerase associates transiently with 'Rho' factor to initiate transcription.
ii. In bacteria, transcription and translation takes place in the same compartment.
iii. RNA polymerase I is responsible for transcription of tRNA.
iv. When hnRNA undergoes capping process, adenylate residues are added at 3' end in a template independent manner.
v. hnRNA is the precurse of mRNA.
(a) i and iv are correct
(b) iii and iv are correct
(c) ii, iii and v are correct
(d) ii and v are correct

60. In the carbon skeleton of the pentose sugar in DNA, what is the attachment point of a base to from a nucleoside?
(a) C_2 (b) C_4 (c) C_1 (d) C_3

61. DNAis very long in relation to its diameter. If a strand of DNA is 0.1 mm in length, what is the ratio of length to diameter,or the axial ratio?
(a) 50,000 (b) 5,000
(c) 10,000 (d) 1,00,000

62. If the DNA of humans contains 3×10^{9}bp, and if an Okazaki fragment, on average,is 2000 bp long, how many initiation points for RNA primase are present in the genome?
(a) 3.5×10^{6} (b) 1.5×10^{6}
(c) 1.5×10^{9} (d) 1.0×10^{6}

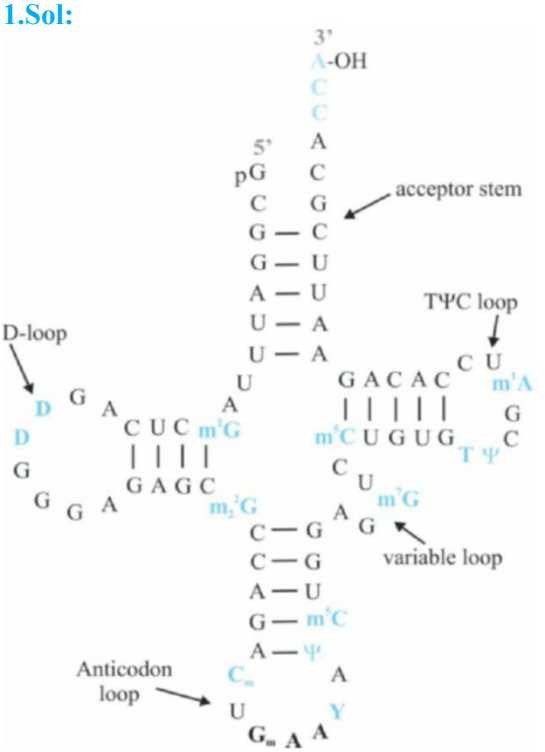
63. Suppose evolution on earth had occurred in such a way that there are 96 amino acids instead of 20. DNA has 12 different types of bases and DNA synthesis occurs in the same way as today. The minimum number of bases per DNA codon would be
(a) 12 (b)8 (c) 2 (d)3

ANSWER KEY

1. b	2. c	3. b	4. b	5. b
6. c	7. a	8. a	9. d	10. b
11. d	12. c	13. a	14. c	15. d
16. a	17. b	18. b	19. b	20. d
21. d	22. b	23. a	24. a	25. c
26. a	27. a	28. c	29. d	30. c
31. b	32. d	33. a	34. c	35. a
36. b	37. b	38. b	39. a	40. b
41. a	42. b	43. c	44. c	45. c
46. d	47. c	48. a	49. c	50. b
51. a	52. b	53. b	54. b	55. a
56. b	57. b	58. b	59. d	60. c
61. a	62. b	63. c		

HINTS & SOLUTIONS

1.Sol:



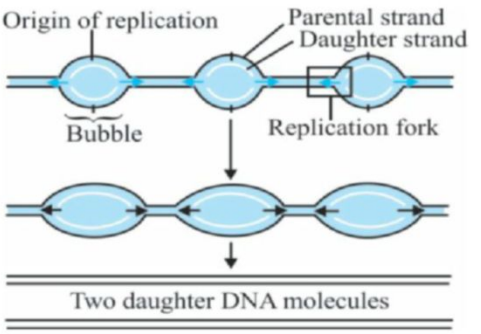
9.Sol: The ^{32}P will end up in the pellet after centrifugation.

11.Sol: Statement D is true.

- The base pairing of guanine (G) and cytosine (C) is just the same in DNA and RNA. So in RNA the important base pairs are: adenine (A) pairs with uracil (U); guanine (G) pairs with cytosine (C)
- The lac repressor protein binds to the operator and blocks RNA polymerase from binding to the promoter and transcribing the operon. ... The promoter is the binding site for RNA polymerase, the enzyme that performs transcription. The operator is a negative regulatory site bound by the lac repressor protein.
- Human genome has approximate 30,000 genes
- Hemophilia A and hemophilia B are inherited in and X-linked recessive pattern. The genes associated with these conditions are located on the Xchromosome, which is one of the two sex chromosomes. In males (who have only one Xchromosome), one altered copy of the gene in each cell is sufficient to cause the condition.

17.Sol:

- Eukaryotic chromosomes are generally much bigger than those of prokaryotes.
- In eukaryotic cells, replication begins at dozens, or even hundreds, of places on the DNA molecule, proceeding in both directions until each chromosome is completely copied.
- Specific protein called DNA A binds to this site causing double strands to separate.
- As the 2 DNA strands open at the origin, replication bubbles are formed. Eukaryotes have many replication bubbles



18.Sol: All the statements are correct except V as viruses with RNA as genetic material mutate faster.

19.Sol: Because in RNA thymine is replaced by Uracil

20.Sol: All the given statements are correct.

21.Sol: Non-coding strand & Antisense strand

31.Sol: (i) Genetic Code for GUU, proline CCU

(ii) mRNA strand is transcribed from DNA based on complimentary base pairing

(iii) Stop codon-UAA.

34.Sol: Methionine - glycine - histidine - lysine - valine; in eukaryotes, the codon that codes for methionine act as starting signal

40.Sol: The correct order of events for synthesis of the lagging strand is primase adds RNA primer, DNA polymerase III creats a stretch, DNA polymerase I removes the primer, and ligase seals the gaps.

41.Sol: Each codon contain 3 Nitrogen bases thus $125\times3=375$

42.Sol:

- Both introns and exons are present in mRNA and tRNA does not possess exons.
- An intron is any nucleotide sequence within a gene that is removed by RNA splicing during maturation of the final RNA product.
- Prokaryotes can't have introns, because they have transcription coupled to translation.
- They don't have time/space for that, since intron splicing will stop the coupling.
- Eukaryotes evolved the nucleus, where splicing can be done.

45.Sol:

- In prokaryotes, regulator genes often code for repressor proteins.
- Repressor proteins bind to operators or promoters, preventing RNA polymerase from transcribing RNA.
- They are usually constantly expressed so the cell always has a supply of repressor molecules on hand.
- Inducers cause repressor proteins to change shape or otherwise become unable to bind DNA, allowing RNA polymerase to continue transcription.
- Regulator genes can be located within an operon, adjacent to it, or far away from it

49.Sol: The shorter DNA fragment move faster towards the anode than the longer fragments.

51.Sol: There are an estimated 19,000-20,000 human protein-coding genes. The estimate of the number of human genes has been repeatedly revised down from initial predictions of 100,000 or more as genome sequence quality and gene finding methods have improved, and could continue to drop further.

52.Sol: The correct sequence is I, IV, II, III

54.Sol: 1+3=4, one initiating code, -AUG and 3 stop codons UAA, UAG, UGA

57.Sol: In a 3.2 Kbp long piec of DNA = 3200bp.

If-820 adenine = 820 Thymine

according to chargaff's rule

purines = pyrinidinies

A= T G = C

820 + 820 = 1640

3200 - 1640 = 1560

G + C = 1560

$$C = \frac{1560}{2} = 780$$

59.Sol: Statement II and V are correct remaining statements are wrong.

60.Sol: Deoxyribose is the sugar found in the backbone of DNA. C_1 of this sugar is linked to the N_1 of a pyrimidine or the N_9 of a purine base by a β - N-glycosidic linkage.

61.Sol: 0.1mm=10^5 nm, diameter of DNA =2 nm.Axial ratio $=1\times10^{5/2}=50,000$ (nm=nanometer)

62.Sol: Divide the total number of base pairs by the size of the Okazaki fragment or $(3\times10^9)/(2\times10^3)=1.5\times10^6$ initiation sites.

63.Sol: If the one base is coding one amino acid, then$(12)^1$=12 but we have 96 amino acids Suppose two basis form one codon, then $(12)^2$ =144.It is sufficient to code 96 or 20 amino acids and hence two, bases from one codon.

Bio Blossoms

EXCRETORY PRODUCTS & THEIR ELIMINATION-2

Mechanism of concentration of filtrate

- The Henle's loop and vasa recta play a significant role in this. The flow of filtrate in the two limbs of Henle's loop is in opposite directions and thus forms a counter current. The flow of blood through the two limbs of vasa recta is also in a countercurrent pattern.

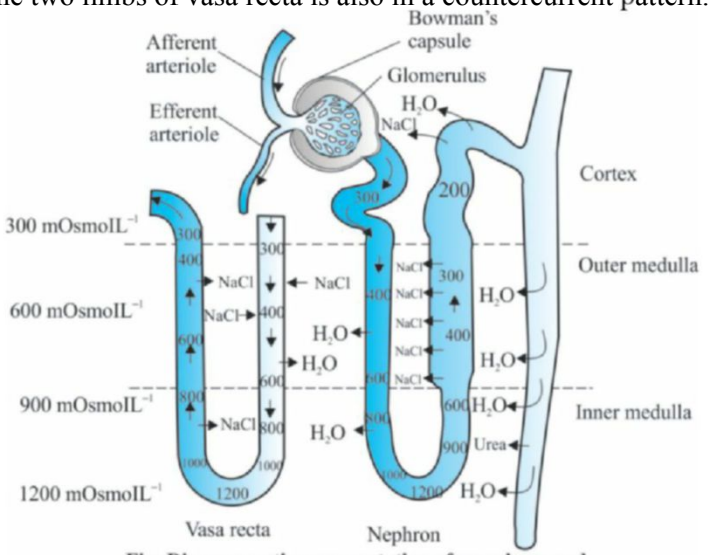


Fig: Diagrammatic representation of a nephron and vasa recta showing counter current mechanisms

- The proximity between the Henle's loop and vasa recta, as well as the counter current in them help in maintaining an increasing osmolarity towards the inner medullary interstitium, i.e., from 300 mOsmolL^{-1} in the cortex to about 1200 mOsmolL^{-1} in the inner medulla. This gradient is mainly caused by NaCl and urea. NaCl is transported by the ascending limb of Henle's loop which is exchanged with the descending limb of vasa recta. NaCl is returned to the interstitium by the ascending portion of vasa recta.
- Similarly, small amounts of urea enter the thin segment of the ascending limb of Henle's loop which is transported back to the interstitium by the collecting tubule.

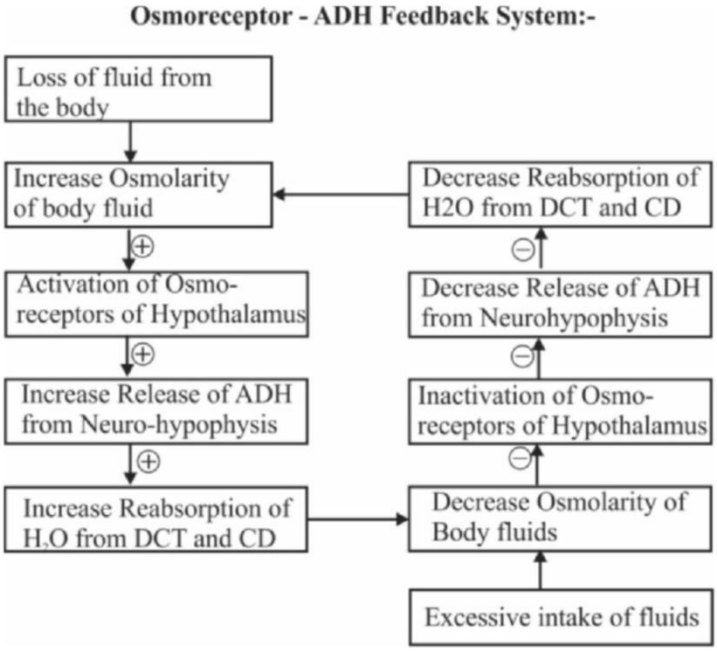
The above described transport of substances facilitated by the special arrangement of Henle's loop and vasa recta is called the counter current mechanism.

This mechanism helps to maintain a concentration gradient in the medullary

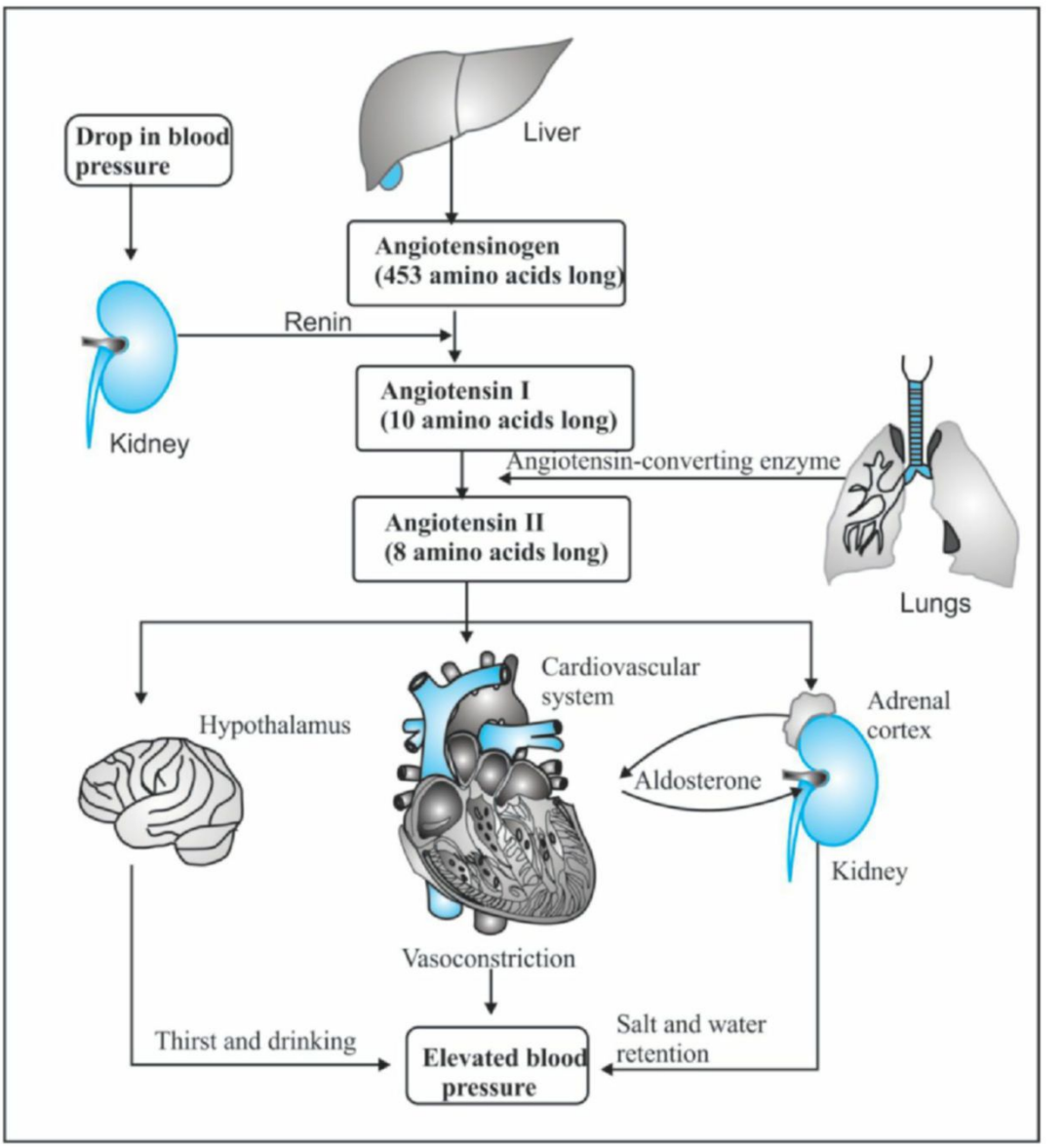
interstitium. Presence of such interstitial gradient helps in an easy passage of water from the collecting tubule thereby concentrating the filtrate (urine). Human kidneys can produce urine nearly four times concentrated than the initial filtrate formed.

Regulation Of Kidney Function

The functioning of the kidneys is efficiently monitored and regulated by hormonal feedback mechanisms involving the hypothalamus, JGA and to a certain extent, the heart.



- Osmoreceptors in the body are activated by changes in blood volume, body fluid volume and ionic concentration. An excessive loss of fluid from the body can activate these receptors which stimulate the hypothalamus to release antidiuretic hormone (ADH) or vasopressin from the neurohypophysis. ADH facilitates water reabsorption from latter parts of the tubule, thereby preventing diuresis.
- An increase in body fluid volume can switch off the Osmoreceptors and suppress the ADH release to complete the feedback. ADH can also affect the kidney function by its constrictor effects on blood vessels. This causes an increase in blood pressure. An increase in blood pressure can increase the glomerular blood flow and thereby the GFR.
- The JGA plays a complex regulatory role. A fall in glomerular blood flow/glomerular blood pressure/GFR can activate the JG cells to release renin which converts angiotensinogen in blood to angiotensin I and further to angiotensin II. Angiotensin II, being a powerful vasoconstrictor, increases the glomerular blood pressure and thereby GFR. Angiotensin II also activates the adrenal cortex to release Aldosterone. Aldosterone causes reabsorption of Na^+ and water from the distal parts of the tubule. This also leads to an increase in blood pressure and GFR. This complex mechanism is generally known as the Renin-Angiotensin mechanism.
- An increase in blood flow to the atria of the heart can cause the release of Atrial Natriuretic Factor (ANF). ANF can cause vasodilation (dilation of blood vessels) and thereby decrease the blood pressure. ANF mechanism, therefore, acts as a check on the rennin angiotensin mechanism.



Micturition

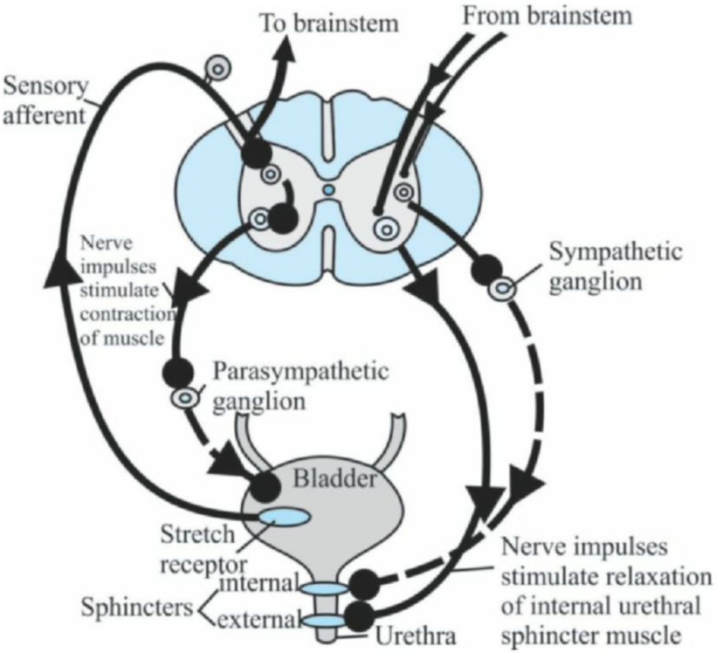
Urine formed by the nephrons is ultimately carried to the urinary bladder where it is stored till a voluntary signal is given by the central nervous system (CNS).

This signal is initiated by the stretching of the urinary bladder as it gets filled with urine. In response, the stretch receptors on the walls of the bladder send signals to the CNS.

The CNS passes on motor messages to initiate the contraction of smooth muscles of the bladder and simultaneous relaxation of the urethral sphincter causing the release of urine. The process of release of urine is called micturition and the neural mechanisms causing it is called the micturition reflex.

An adult human excretes, on an average, 1 to 1.5 litres of urine per day. The urine formed is a light yellow coloured watery fluid which is slightly acidic (pH-6.0) and has a characteristic odour. On an average, 25-30gms of urea is excreted out per day.

Various conditions can affect the characteristics of urine. Analysis of urine helps in clinical diagnosis of many metabolic disorders as well as malfunctioning of the kidney. For example, presence of glucose (Glycosuria) and ketone bodies (Ketonuria) in urine are indicative of diabetes mellitus.



Composition of urine

- **Water:** 95%, Salts – 2%, Urea- 2.6%, Uric acid-0.3%, traces of creatine, ammonia, etc.
- **Color:** Pale yellow due to the presence of urochrome pigment which is produced as a result of haemoglobin breakdown.
- **Specific gravity:** 1.015 – 1.025
- **Odour:** Aromatic, smells like ammonia upon standing.
- **Volume:** 1-2 litres every day however varies largely.

  Analysis of urine in clinical diagnosis of many metabolic disorders of kidney. Presence of glucose (glycosuria) and ketone bodies (ketonuria) in urine indicates diabetes mellitus.

Other organs in excretion in chordates:

- **Lungs:** Lungs remove large amounts of CO_2 (18 litres/day) and also significant quantities of water every day.
- **Liver:** Liver, the largest gland in our body, secretes bile containing substances like bilirubin, biliverdin, cholesterol, degraded steroid hormones, vitamins and drugs. Most of these substances ultimately pass out along with digestive wastes.
- **Skin:** The sweat and sebaceous glands in the skin can eliminate certain substances through their secretions. Sweat produced by the sweat glands is a watery fluid containing NaCl, small amounts of urea, lactic acid, etc. Though the primary function of sweat is to facilitate a cooling effect on the body surface, it also helps in the removal of some of the wastes mentioned above. Sebaceous glands eliminate certain substances like sterols, hydrocarbons and waxes through sebum. This secretion provides a protective oily covering for the skin.

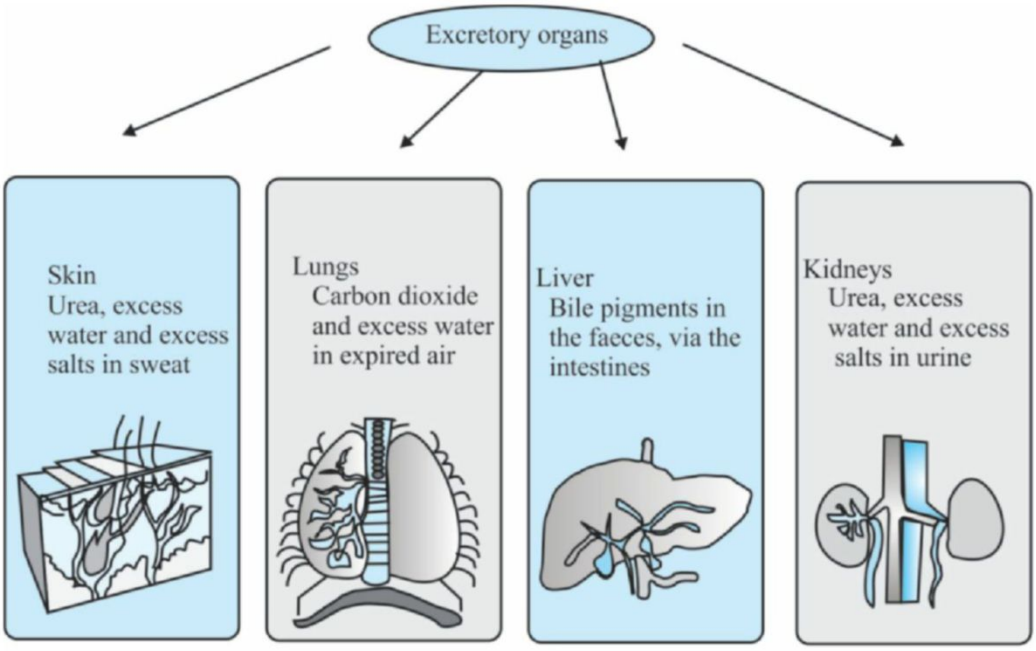


Fig: Other organs in excretion

Disorders Of The Excretory System

1. **Kidney Failure:** Malfunctioning of kidneys can lead to accumulation of urea in blood, a condition called uremia, which is highly harmful and may lead to kidney failure. In such patients, urea can be removed by a process called hemodialysis.
   Blood drained from a convenient artery is pumped into a dialysing unit after adding an anticoagulant like heparin. The unit contains a coiled cellophane tube surrounded by a fluid (dialysing fluid) having the same composition as that of plasma except the nitrogenous wastes.
   The porous cellophane membrane of the tube allows the passage of molecules based on concentration gradient. As nitrogenous wastes are absent in the dialysis fluid, these substances freely move out, thereby clearing the blood. The blood is pumped back to the body through a vein after adding anti-heparin to it.
2. **Renal Calculi:** Stone or insoluble mass of crystallised salts (oxalates, etc.) formed within the kidney. These produce severe pain if they result in obstruction of urethra. Smaller sized calculi or stones are expelled by the body, while larger ones require surgical procedure to be expelled.
3. **Uremia:** Malfunctioning of kidneys due to accumulation of urea in blood. It is very harmful and leads to renal failure. For such kind of patients we go for hemodialysis
4. **Glomerulonephritis:** Inflammation of glomeruli of kidney.

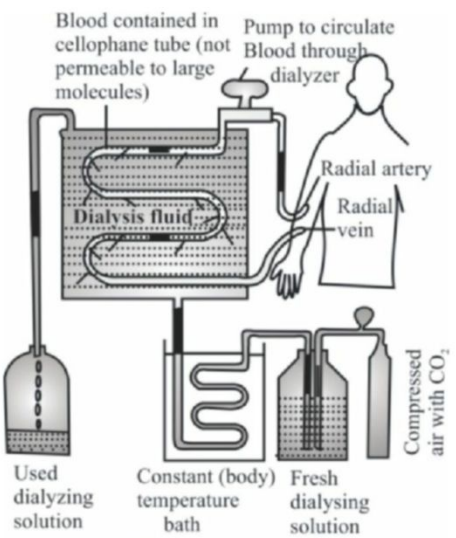


Fig: Dialysis

Exercise

Regulation Of Kidney Function

1. Volume of urine is regulated by
   (a) Aldosterone
   (b) Aldosterone and ADH
   (c) Aldosterone, ADH and testosterone
   (d) ADH
2. Water reabsorption in kidney is controlled by
   (a) ADH (b) Aldosterone
   (c) GH (d) Oxytocin
3. Antidiuretic hormone(ADH)
   (a) Increase water reabsorption
   (b) Increase water release
   (c) Increase Na^+ reabsorption
   (d) Decrease urea synthesis
4. When there is a decrease in blood pressure or blood volume in the afferent arteriole of the glomerulus, Juxtaglomerular Apparatus releases an enzyme,
   (a) Renin , into the blood stream
   (b) Pepsin, into the blood stream
   (c) Kinase, into the blood stream
   (d) Invertase, into the blood stream
5. In micturition
   (a) Ureters contract (b) Urethra contracts
   (c) Urethra relaxes (d) Ureters relax

Disorders Of Excretory System

6. A severe fall in blood pressure disturbs the function of kidneys and reduces
   (a) Renal filtration
   (b) Glomerular filtration
   (c) Reabsorption
   (d) Secretion of nitrogenous wastes
7. Excretion of bile pigments in urine indicates
   (a) Anaemia (b) Diabetes
   (c) Gout (d) Jaundice
8. Workers in deep mines usually suffer from dehydration because
   (a) Water is lost due to evaporation
   (b) Water is lost due to defecation
   (c) Water is lost in the form of sweat
   (d) Water is lost along with salts in the form of sweat
9. If a man takes in large amount of proteins he is likely to secrete more amount of
   (a) Urea (b) Uric acid
   (c) Sugar (d) Carbon dioxide
10. What will happen if one kidney of a person is removed
    (a) He will survive and remain normal
    (b) He will die
    (c) Urea will go on accumulating in the blood
    (d) Urination will stop
11. In Diabetes mellitus the patient drinks more water as there is urinary loss of
    (a) Salt (b) Insulin
    (c) Protein (d) Glucose
12. Haemodialysis is done in the condition when a person is suffering from
    (a) Anaemia (b) Uraemia
    (c) Goitre (d) Diabetes
13. If loops of Henle were absent from an individual's nephron, which one of the following is to be expected?
    (a) The urine will be more dilute
    (b) There will be hardly any change in the quality and quantity of urine formed
    (c) The urine will be more concentrated
    (d) There will be no urine formation
14. The nonsuprative inflammation of the kidneys due to bacterial infection is called
    (a) Uraemia (b) Kidney stones
    (c) Haematuria
    (d) Nephritis or Bright's disease
15. Inflammation of pelvis is called
    (a) Pyelitis (b) Nephritis
    (c) Glucosuria (d) Haematuria
16. Kidney stones are formed by precipitation of
    (a) Uric acid (b) Calcium phosphate
    (c) Calcium oxalate (d) All the above
17. The level of blood sugar rises to a very great extent. The excess of glucose from the blood is removed along with urine, this disease is called
    (a) Glycosuria (b) Uraemia

(c) Pyelonephritis (d) Nephritis

ANSWER KEY

1. a	2. a	3. a	4. a	5. c
6. b	7. d	8. c	9. a	10. a
11. d	12. b	13. a	14. d	15. a
16. d	17. a			

HINTS & SOLUTIONS

1. **(a)** Aldosterone is a hormone that causes the tubules of the kidneys to retain sodium and water. Aldosterone is a steroid hormone (mineralocorticoid family). It acts on the distal tubules and collecting ducts of the kidney to cause the conservation of sodium, secretion of potassium, increased water retention and increased blood pressure. The overall effect of aldosterone is to increase reabsorption of ions and water in the kidney. Antidiuretic hormone (ADH), is a neurohypophysial hormone found in most mammals. Its two primary functions are to retain water in the body and to constrict blood vessels. Vasopressin regulates the body's retention of water by increasing water reabsorption in the collecting ducts of the kidney nephron.
2. **(a)** ADH (antidiuretic hormone)
   Increases the reabsorption of water from the urine in the renal system back into the blood. This increases intravascular fluid volume and decreases the amount of urine voided out of the body. Thus ADH conserves water in the kidneys and returns that fluid back to the general circulation. This conservation of urine acts to increase blood pressure because total intravascular fluid volume is increased.
3. **(a)** refer explanation no. 36
4. **(a)** When systemic hypotension, or low blood pressure throughout the body, occurs, receptors in your blood vessels called baroreceptors sense this change. Cells of the kidney's juxtaglomerular apparatus get involved as well. Detection by one or both of these mechanisms leads juxtaglomerular cells in the kidneys to release an enzyme called renin. Renin is an enzyme released by the juxtaglomerular cells of the kidneys in response to low blood pressure, causing the transformation of angiotensinogen to angiotensin I.
5. **(c)** Micturition, or urination, is the act of emptying the bladder. When the bladder is full of urine, stretch receptors in the bladder wall trigger the micturition reflex. The detrusor muscle that surrounds the bladder contracts. The internal urethral sphincter relaxes, allowing for urine to pass out of the bladder into the urethra. Both of these reactions are involuntary. The external urethral sphincter is voluntary. It must be relaxed for urine to flow through the urethra and outside the body.
6. **(b)** Glomerular filtration occurs due to the pressure gradient in the glomerulus.
   Increased blood volume and increased blood pressure will increase GFR.
   The glomerular filtration rate is directly proportional to the pressure gradient in the glomerulus, so changes in pressure will change GFR.
   GFR is also an indicator of urine production, increased GFR will increase urine production, and vice versa.
7. **(d)** Bilirubin is excreted in bile and urine, and elevated levels may indicate certain diseases. It is responsible for the yellow colour of bruises and the yellow discoloration in jaundice. Its subsequent breakdown products, such as stercobilin, cause the brown colour of feces.
8. **(c)** Workers in deep mines usually suffer from dehydration because with the possibility of a higher incidence of heat illness among surface miners. Heat exhaustion symptoms (headache through to irritability), and / or three out of seven of the heat stroke symptoms (hot and dry skin through to convulsions).

Water is lost along with salts in the form of sweat.

9. (a) When you eat protein, your body breaks it down into amino acids, which are used to replace the protein in your body. Your body cannot store excess protein, and the extra amino acids are catabolised into energy and ammonia. The ammonia is then turned into urea and eliminated from your body.

10. (a) Many people with one kidney can live essentially the same as those with two. The remaining kidney is often able to compensate for its missing counterpart. As long as such people eat sensibly, get plenty of exercise, monitor their blood pressure and receive regular checkups, they can expect to lead a healthy life with only one kidney. Even if the lone kidney stops functioning, treatment options are available.

11. (d) In most people with Type 1 or Type 2 diabetes, the thirst builds slowly enough that it is often incredibly difficult to notice until other symptoms present themselves or until the point of major dehydration. When glucose becomes hyper-concentrated in your bloodstream, usually about 200mg/dL – though this number varies from person to person, your kidney loses the ability to reuptake (pull out) glucose from water. Under normal circumstances, almost all glucose is pulled out of urine and back into the body.

12. (b) Haemodialysis: This is carried out by leading the person's blood through an 'artificial kidney' machine that cleans the blood and returns it by tubing to a vein. It can be carried out over a few hours, and needs to be repeated, on average, every couple of days. It is done in a specialised dialysis unit attached to a hospital.

If renal failure is irreversible (a condition known as end stage renal failure or ESRF), then long-term dialysis becomes necessary. Kidney transplantation is carried out whenever possible.

13. (a) Urine will be more dilute because concentration of urine due to counter current mechanism. loop of Henle of juxtraglomenular nephrons take part in counter current mechanism.

So if the loop of Henle is absent then that counter mechanism will not take part in system so there will be no issues of concentration of urine.

Thus it will get more dilute.

14. (d) Bright's disease is a historical classification of kidney diseases that would be described in modern medicine as acute or chronicnephritis. It was characterised by edema, the presence of albumin in the urine and was frequently accompanied by high blood pressure (hypertension) and evidence of heart disease.

15. (a) Pyelonephritis is an inflammation of the kidney tissue, calyces, and renal pelvis. It is

commonly caused by bacterial infection that has spread up the urinary tract or travelled through the bloodstream to the kidneys. In other words, pyelitis together with nephritis is collectively known as pyelonephritis.

16. (d)

Biochemical Investigations of patients with kidney stone Risk Factores	
Investigation	Risk factor for stone formation
Blood	
Calcuim	Hypercalcemia (primary, hyperparathyroidism, vitamin D toxicity, sarcoidosis)
Urate	Hyperuricemia (gout)
Potassium Bicarbonate Chloride	Hyperchloremia with hypokalemia and low bicarbonate (distal renal tubular acidosis)
Phosphate	Hypophosphatemia (renal phosphate leak)
24 - hour Urine	
Urine Volume	Low urine volume promotes urine supersaturation
Calcium	Hypercalciuria
Phosphate	Phosphaturia
Sodium	High urinary sodium
Oxalate	Hyperoxaluria
Citrate	Hypocitraturia
Uric Acid	Hyperuricosuria
Magnesium	Hypermagnesiuria
Cystine	High urinary cystine

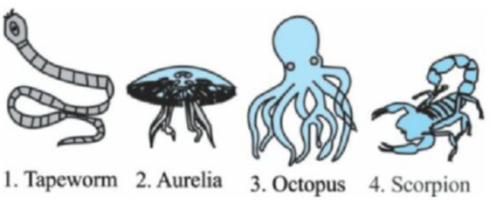
17. (a) Glucosuria occurs when the capacity of the kidney to tolerate blood glucose is exceeded in the blood. This is known as renal threshold for glucose, the value for which is 180 mg/100 ml of blood. If the glucose concentration in the blood exceeds this value, it is excreted in urine. At 180 mg/100 ml of blood glucose the kidney reabsorbs 350 mg of glucose per minute, this is known as tubular maximum for glucose (T-G). Any amount of glucose being filtered by the glomerular filtrate more than this into the kidney per minute is excreted.

Figure Arcade

TARGET NEET

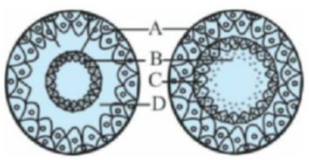
Animal Kingdom

1. The figure shows four animals 1, 2, 3 and 4. Select the correct answer with respect to a common characteristics of two of these animals:



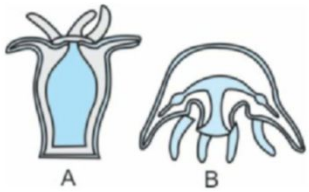
(a) 3 and 4 have a true coelom
(b) 1 and 4 respire mainly through body wall
(c) 2 and 3 show radial symmetry
(d) 1 and 2 have Cnidoblasts for self defense

2. Given below is a diagrammatic sketch of germinal layers. Identify the part labelled A,B,C and D select the correct option



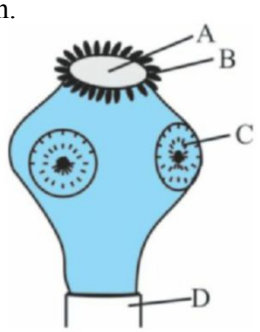
	A	B	C	D
(a)	Ectoderm	Endoderm	Mesoderm	Mesoglea
(b)	Ectoderm	Endoderm	Mesoglea	Mesoderm
(c)	Ectoderm	Mesoderm	Endoderm	Mesoglea
(d)	Ectoderm	Mesoglea	Mesoderm	Endoderm

3. What do the given figures A and B represent and identify their habitats. Choose the correct option.



(a) A: Polyp-free swimming, B: Medusa-sessile
(b) A:Medusa-free swimming, B: Polyp-sessile
(c) A: Polyp-sessile, B:Medusa-free swimming
(d) A: Medusa-sessile, B: Polyp-free swimming

4. In the following diagram identify the parts indicated by alphabets. Choose the correct option.



(a) A-Suctorial mouth, B-Hooks, C-Sucker, D-Segments
(b) A-Sucker, B-Hooks, C-Suctorial mouth, D-Proglottids
(c) A-Rostellum, B-Hooks, C-Sucker, D-Proglottids

(d) A-Rostellum, B-Hair, C-Sucker, D-Segments

5. Select the correct answer w.r.t common characteristics of two of the animals given in the figure A, B,C and D.

A

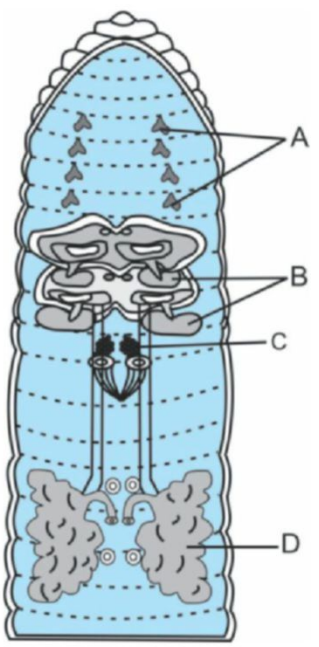
B

C

D

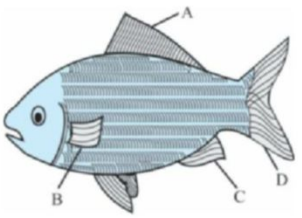
(a) A and C shows metagenesis
(b) B and D are eucoelomate
(c) B and D are segmented
(d) A and C have cnidoblast for anchorage defense and for the capture of prey

6. Given is the diagram of the reproductive system of earthworm. Identify A, B, C and D.



(a) A-Seminal vesicle, B-Spermathecae, C-Prostrate gland, D-Ovary
(b) A-Spermathecae, B-Seminal vesicle, C-Ovary, D-Prostrate gland
(c) A-Seminal vesicle, B-Prostrate gland, C-Spermathecae, D-Accessory gland
(d) A-Ovary, B-Vas deferens, C-Prostrate gland, D-Spermathecae

7. Given is a diagram of a freshwater fish. Identify the types of fin.

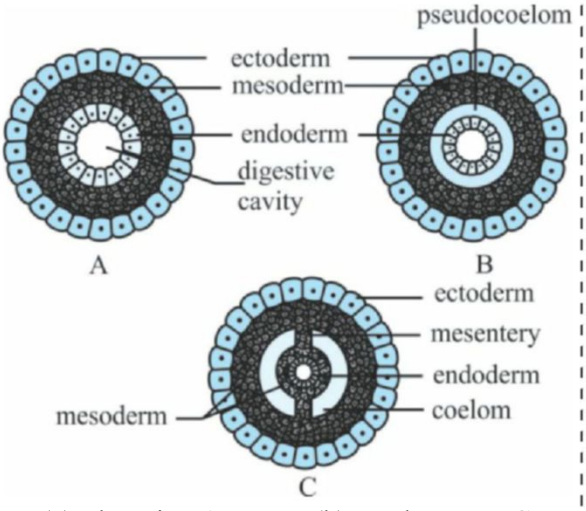


(a) A-dorsal, B-pectoral, C-anal, D-caudal
(b) A-ventral, B-pectoral, C-pelvic, D-caudal
(c) A-dorsal, B-pectoral, C-pelvic, D-caudal
(d) A-ventral, B-pectoral, C-anal, D-caudal

8. Given Figure A represents Catla. Identify the correct option consisting of characters which represents 'A' as member of the class Osteichthyes

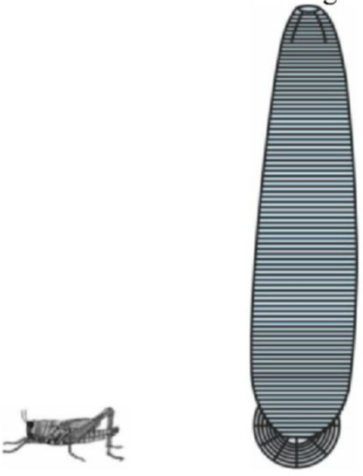
(a) Notochord is persistent throughout life
(b) Teeth are modified scales which are backwardly directed
(c) They have four pair of gills which are covered by an operculum on each side
(d) They have internal fertilization and many of the are viviparous

9. Given is the cross section of the body of an invertebrate with eucoelom. Identify the animal which has this body plan.



(a) Planaria - A (b) Earthworm - C
(c) Roundworm - C (d) Tapeworm - B

10. Among the given figures A,B , C and D, identify the animals which is/ are dioecious, coelomate with metameric segmentation?


A

B

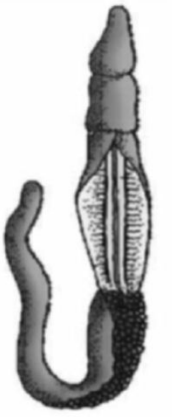

C


D

Identify the correct options
(a) A and C (b) A and D
(c) C and D (d) B and C

11. Sexes are separate, Excretory system is absent and fertilization is usually external this is correct for

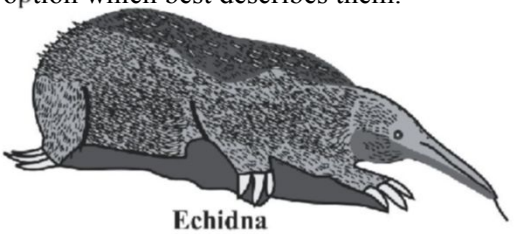

(a)

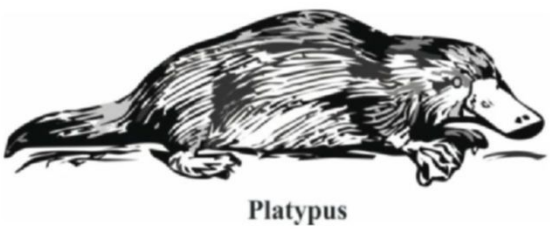

(b)


(c)


(d)

12. Given are two animals. Identify the correct option which best describes them.


Echidna

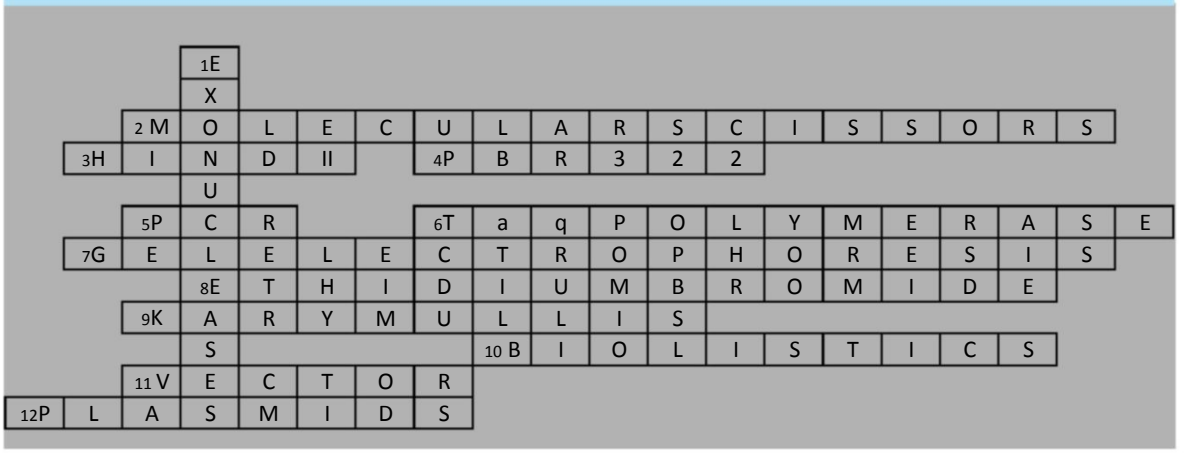

Platypus

A. Both are egg laying mammals
B. Both are lizard-like reptiles
C. Dinosaur is their common ancestor
D. Platypus Males have poisonous spurs on the inside of the back legs
(a) Only A is correct
(b) Only B is correct
(c) Both B and C are correct
(d) Both A and D are correct

ANSWER KEY

1. a	**2.** a	**3.** c	**4.** c	**5.** b
6. b	**7.** a	**8.** c	**9.** b	**10.** b
11. c	**12.** d			

PUZZLE SOLUTION: JUNE MONTH ISSUE



(NES) .....A competitive edge for cracking NEET

NEET Edge Series

EVOLUTION

1. Which one of the following is incorrect about the characteristics of protobionts as envisaged in the abiogenic origin of life?
   (a) They were able to reproduce sexually
   (b) They could separate combinations of molecules from the surroundings
   (c) They could maintain an internal environment
   (d) They were partially isolated from the surroundings
2. In the early atmosphere , the organic molecules once formed accumulated in water and their degradation was extremely slow. Why suchtransformation is not possible in the present atmosphere?
   (a) Microbes will decompose living particles that arise by more chance
   (b) Reducing atmosphere will reduce the molecules
   (c) Oxidising atmosphere will oxidize molecules
   (d) Both (a) and (c)
3. Which of the following is not evidence for the role of endosymbiosis in the origin of eukaryotes?
   (a) The DNA in the eukaryotes nucleus codes for some enzymes in mitochondria
   (b) Mitochondria reproduced by binary fission
   (c) Chloroplasts have their own DNA.
   (d) The inner membrane of a chloroplast is similar to prokaryotic membrane.
4. The change of the lighter coloured variety of peppered moth, Biston betularia to its darker variety (Carbonaria) is due to
   (a) Deletion of a segment of genes due to industrial pollution
   (b) Translocation of a block of genes in chromosomes in response to heavy carbons
   (c) Industrial carbon deposited on the wings of the moth resulting in darker variety
   (d) Mutation of single mendelian gene for survival in smoke laden industrial environment.
5. Which of these statements is true?

Comparison of Country and City Moths			
Location		Numbers of Light Moths	Numbers of Dark Moths
Country	Released	496	488
	Recaptured	62	34
City	Released	137	493
	Recaptured	18	136

   (a) A higher percentage of dark moths were recaptured in the country compared to dark moths recaptured in the city.
   (b) A higher percentage of light moths were recaptured in the city compared to dark moths recaptured in the city.
   (c) A higher percentage of light moths were recaptured in the country compared to dark moths recaptured in the country.

(d) A higher percentage of light and dark moths were recaptured in the country compared to light and dark moths recaptured in the city.

6. Read the following four (A-D) statements :

i. Natural selection is a process in which heritable variations enabling better survival are enabled to reproduce greater number of progeny.

ii. When migration of a section of population to another place and population occurs, gene frequencies changes

iii. If loss of gene migration happens multiple times there would be a gene flow

iv. If loss of considerable gene from a small population occurs by chance it is called as genetic drift

How many of the above statements are true:-

(a) Two (b) One (c) Four (d) Three

7. An inter breeding population of finches became separated geographically, forming two isolated groups. Each group then became subject to different selective pressures. One group was then introduced into the habit of other. Which one of the following would determine whether they now formed two distinctive species?

(a) They failed to produce fertile F1 hybrids

(b) They had been separated for more than 3 million years

(c) Their plumage had become markedly different

(d) They showed marked differences in the shape of their beaks.

8. Darwin's finches are best example of adaptive radiation which of the following best describe this adaptive radiation?

(a) The evolutionary process that allows for the change that occur within the same lineage.

(b) The genetic variability that can be found among individuals of same species.

(c) A sudden diversification of a group of organism from closely related species.

(d) The evolutionary process by which different forms, adapted to different niches, arose from a common ancestors.

9. According to Darwinism, fitness level of which category of microbes is highest?

(a) Which do not divide but is capable to resist any change in medium

(b) Which divide slowly and make few hundred individuals in an hour, all are sensitive to surroundings

(c) Which divide and make two types of colonies i.e., resistant and sensitive

(d) Which divide fast and make millions of individuals within hours, They have built in variations in terms of ability to utilize a feed component

10. Consider following statements regarding microsphere

i. They had catalytic activity

ii. They were spherical in shape and 1-2 μm in diameter.

iii. They provided partial isolation to contents inside it, from external environment

iv. They had concentric double layered boundaries.

Which of the above statements are incorrect?

(a) i and ii (b) iv only

(c) ii only (d) None of these

11. Which of the following is incorrect?

(a) Lobefin fish evolved into first amphibians.

(b) Ichthosaurus evolved about 200 mya.

(c) Stegosaurus was 20 feet in height and had huge fearsome dagger like teeth.

(d) Reptiles of different shapes and size dominated on earth around 200 mya.

12. Read the following three statement (A to C) and mark the right option

i. The thorns in Bougainvillea and tendrils in cucurbits represent divergent evolution

ii. The similarity in the eyes of Octopus and monkeys is the result of convergent evolution

iii. The potato and sweet potato are the examples of homology

(a) ii and iii correct
(b) i and ii correct
(c) i and iii correct
(d) All i, ii and iii correct

13. Given below are four statements (A-D) each with one or two blanks. Select the option which correctly fills up the blanks in two statements

Statements:

(A) Wings of butterfly and brids look a like and are the results of (i), evolution.
(B) Miller showed that CH_4, H_2, NH_3 and (i), when exposed to electric discharge in a flask resulted in formation of (ii)
(C) Vermiform appendix is a (i) organ and an (i) evidence of evolution.
(D) According to Darwin evolution took place due to (i) and (ii) of the fittest.

(a) (A)- (i) Convergent,
(B) - (i) Oxygen, (ii) nucleosides
(b) (A)- (i) Small variations, (ii) Survival,
(B) (i) Convergent
(c) (C)- (i) Vestigial, (ii) Anatomical
(D)- (i) Mutations, (ii) Multiplication
(d) (B)- (i) Water vapour, (ii) Amino acids
(C)- (i) Rudimentary, (ii) Anatomical

14. Mark the incorrect statement about the first noncellular form of life ?

(a) These capsules have molecules with no ability of self replication.
(b) They would have been giant molecules and the first living giant molecules was probably a RNA
(c) Originated about 3 billion years back
(d) It was a cluster of nucleoprotein surrounded by lipid coat

15. Some major events in the early history of life are mentioned here.

i. First animal ii. First eukaryotes
iii. First Genes
iv. First heterotrophic prokaryotes
v. First autotrophic prokaryotes.

Identify the option which places them in correct order

(a) ii, iii, iv, i, v (b) iv, iii, i, ii, v
(c) iii, iv, v, ii, i (d) v, ii, iii, iv, i

16. Read the following three statements (A to C) and mark the most appropriate option

A. The fitness in the 'survival of the fittest' is based upon the characteristics that are inherited
B. Darwin's variations were small and directional
C. The fitness is the end result of ability to adapt

(a) Only B and C correct
(b) Only A and B correct
(c) Only A and C correct
(d) All A, B, and C correct

17. Which of the following statements are incorrect?

i. Hugo devries called mutations as saltation because they brought speciation.
ii. Genetic drift is directional end can cause elimination of certain alleles in the population.
iii. Genetic bottleneck effect leads to sharp increase in the size of population or anthropogene due environmental.
iv. Founder effect results in formation of a different genotype in a new settlement.

(a) i and iv (b) iii and iv
(c) i and iii (d) ii and iii

18. Read the following statements and select the correct ones

i. The early belief of the spontaneous origin of life was disproved by Louis Pasteur
ii. Founder of 'theory of catastophism ' is Georges Cuvier
iii. Cosmozoic theory of the origin of life was proposed by Richter.
iv. Idea of life originates from pre-existing life is referred to as biogenesis theory.

(a) i, ii and iii (b) i, ii, iii and iv
(c) i, iii and iv (d) i and iv

19. An Australian mole is actually a marsupial rather than a placental animal like the North American or European mole. The two animals are similar in appearance because
(a) The selection pressures on both were similar
(b) They have undergone a long period of coevolution
(c) There are practically no placental mammals in Australia
(d) Marsupials and placental mammals are closely related

20. Giraffes have long neck this length will not further increase any more from generations to generations this is because of natural selection.
(a) Directional (b) stabilizing
(c) Disruptive (d) centrifugal

21. "Frequency of resistant viruses increases in population by using medication". Mark the best explanation regarding this statement in the light of Lederberg – lederberg experiment ?
(a) Nature favours those characteristics which provide advantage in the current environment
(b) Drugs create resistant pathogens
(c) Nature selects resistant individuals that are already present in population.
(d) Both (a) and (c)

22. We know much about fossil fishes, snails and corals but not much about ancient sea weeds. Why do you suppose this is the case?
(a) A mass extinction wiped out the sea weeds but animals survived.
(b) Plants moved onto land leaving only animals in the sea.
(c) There were no sea weeds in the ancient oceans.
(d) Sea weeds were too soft to fossilize well.

23. Find the incorrect statement
(a) Evolution at genetic level like sickle cell anemia is macroevolution
(b) Whales and seals do not contain gill slits in adults as their adaptation to aquatic life is secondary
(c) According to Darwin , any population has built in variation in characteristics
(d) Darwin highlighted the importance of small and gradual differences in evolution, whereas devries focused an abrupt and drastic changes an cause of origin of species.

24. Which of the following statement is false?
(a) Sympatric species originate by the sudden development of reproductive isolation between segments of a species population due to sudden change in their genotype.
(b) The sum total of genes of all the species in an area constitutes the gene pool.
(c) The gene frequency refers to the proportion of an allele in the gene pool as compared with other alleles.
(d) Both (a) & (c)

25. Selection will not eliminate a lethal recessive allele from a large population of diploid organisms because:
(a) Gene fixation will occur in the population
(b) Heterozygotes are at a selective advantage
(c) The allele will have some good effects and these will become dominant
(d) There will always be some heterozygote carrier for the allele

26. A potential damage to a population that has been greatly reduced in number is the
(a) Loss of genetic variability
(b) Tendency towards assortative mating
(c) Reduced gene flow
(d) Hardy – Weinberg disequilibrium

27. Which of the following is the correct sequence of events in the origin of life.
i. Formation of protobionts
ii. Synthesis of organic monomers.
iii. Synthesis of organic polymers.
iv. Formation of DNA- based genetic systems.
(a) i, ii, iii, iv (b) i, iii, ii, iv
(c) ii, iii, i, iv (d) ii, iii, iv, i

28. In a hypothetical human population in Hardy-Weinberg equilibrium, the frequencies of the alleles IA, IB and i are respectively 0.1, 0.3 and 0.6. What percentage of the population is expected to have 'B' type blood?
(a) 27 (b) 9 (c) 36 (d) 45

29. In a population of 1,000 individuals, 400 are homozygous Rh+(DD), 240 are heterozygous Rh+(Dd) and 360 are Rh-(dd). The frequency of recessive allele (d) in that population is
(a) 0.48 (b) 0.6 (c) 0.52 (d) 0.96

30. Read the given statements
i. Theory of pangenesis was given by Lamarck to explain the inheritance of acquired character.
ii. According to Ernst Haeckel, Ontogeny is recapitulation of phylogeny i.e., the development of an organism reveals the evolutionary history.
iii. In modern synthetic theory, the unit of evolution is individual.
iv. Weismann's theory of germplasm rejected Darwin's theory of pangenesis.
(a) i, ii and v are correct
(b) ii & iv are correct
(c) i, iv & v are correct
(d) i, ii, and iv are correct

31. Mark the incorrect statements
(a) Homology in vertebrates brain indicates their common ancestry
(b) The idea of survival of fittest of Alfred R Wallace was based on his studis on Galapagos islands
(c) The fitness of the individuals, according to Charles Darwin, means reproductive fitness
(d) All of the above

32. Fishermen use nets of a large mesh size to capture larger adult fish, leaving smaller adults.
This would result in
(a) Disruptive selection as more fish acquire peripheral character value at both ends of the distribution curve
(b) Stabilizing selection as individuals with mean weight have maximum chance of survival
(c) Directional selection leading to an increase in the mean weight
(d) Directional selection leading to a decrease in the mean weight

33. Which of the following statements are True (T) or False (F).
i. Homo sapiens arose in Africa and removed across continents and developed into distinct races.
ii. Agriculture came around 18000 years ago and human settlement started.
iii. During ice- age between 75000-10000 years ago modern Homo sapiens arose
iv. Neanderthal man had a brain size of 1400 CC and lived between 100000-40000 years back.

	i	ii	iii	iv
(a)	T	F	T	F
(b)	T	F	F	T
(c)	T	F	T	T
(d)	T	F	F	F

34. Study the following table and identify the correct option for A, B and C

	Fossil	Cranial capacity	Time of appearance
I.	Australo-pithecus	A	5 mya
II.	Homo sapiens neanderthalensis	1400 cc	B
III.	C	900 cc	1.5 mya

(a) 700 cc 34000 years ago Homo erectus
(b) 500 cc 11000 years ago Homo habilis
(c) 800 cc 50,000 years ago Ramapithecus
(d) 500 cc 100,000 years ago Homo erectus

35. Mark the correct statements
(a) Agriculture came around 18000 yrs back

(b) The skull of modern human resembles more closely to baby chimpanzee
(c) Homo erectus lived in east and central Asia and used hides to protect their bodies
(d) All of these

36. Arrange the following human ancestors in ascending order, from earliest to latest:
i. Homo erectus
ii. Australopithecus
iii. Homo habilis
iv. Homo neanderthelensis
(a) ii, i, iii, iv (b) i, ii, iii,iv
(c) iv,iii,i,ii (d) ii,iii,i,ii

ANSWER KEY

1. a	**2.** d	**3.** d	**4.** a	**5.** c
6. c	**7.** a	**8.** d	**9.**d	**10.** c
11. c	**12.** b	**13.** b	**14.** a	**15.** c
16. d	**17.** d	**18.** b	**19.** a	**20.** b
21. d	**22.** d	**23.** a	**24.** b	**25.** d
26. a	**27.** c	**28.** d	**29.** a	**30.** b
31. b	**32.** d	**33.** c	**34.** d	**35.** b
36. d				

HINTS & SOLUTIONS

1. (a) Microspheres and coacervates did not reproduce sexually instead they reproduced asexually by budding and fission.

2. (d)

3. (d) Origin of a eukaryotic cell is by a symbiotic origin or by invagination. As per symbiotic origin of eukaryotic cell, primitive aerobic bacteria was engulfed by anaerobic predator cell and it could not digest the engulfed particle. So the engulfed anaerobic particle got itself established into the host cell as an symbiont (Endosymbiont). Predator host cell became an eukaryotic cell. The predator host cell which captured both aerobic bacteria and blue green algae became an eukaryotic plant cell. Aerobic bacteria established itself as mitochondria and blue green algae established itself as chloroplast.

4. (a) **5. (c)** **6. (c)**

7. (a) Once inter-breeding population of finches , now have failed to produce fertile F1 hybrids this means they have now formed two distinct species

8. (d) Presence of evolution of different species in a given geographical area starting from a point and radiating to other habitats is called Adaptive Radiation.

9. (d)

10. (c) Microspheres are microscopic membrane bound spheres formed when protenoids are boiled in water and allowed to cool.

11.(c) Tyrannosaurus rex was 20 feet in height and had huge fearsome dagger like teeth. Lobefin fish evolved into first amphibians. Theses fish had thick and stout fins, and could move on land move back to water. Around 200 mya, some reptiles went back to water and developed fish like characters, to form ichthyosaur. Reptiles of different shapes and sizes dominated on earth around 200 mya. Mesozoic era is called age of reptiles.

12. (b) **13. (b)**

14. (a) The Capsules had molecules which had ability of self replication.

15. (c) **16. (d)** **17. (d)** **18. (b)**

19. (a) Australian mole resemble to that of the mole of Europe or North America. This is the result of convergent evolution, in which similar features develop separately in different species due to same selection pressures.

20. (b) Once the average value of fitness (Phenotype) meets the enivornmental changes, directional selection will be over taken by stabilizing natural selection.

21. (d) This is according to use and disuse theory, i.e., if a organ is used more often then it gets stronger. The person who does the work in fields and hold the sickles etc in the hand, for them the epidermis on palm

becomes thicker.

22. (d) Sea weeds include multicellular algaes and they are too soft to fossilize.

23. (a)

24. (b) Gene pool is the set of all genes (genetic information) of a single species in any population.

25. (d) Heterozygotic condition is when one gene is dominant and another gene is the recessive. In such conditions lethal gene will be recessive and dominant gene will express itself. The recessive gene can be expressed in the next generation and selection cannot eliminate lethal recessive allele from large population of diploid organisms. Recessive lethals produce effect only in homozygous condition, their heterozygotes are normal.

26. (a) Potential damage to a population that has been greatly reduced in number is loss in its genetic variability (Bottle neck effect)

27. (c)

28. (d)

Allelic frequencies:

p (IA) = 0.1

q (IB) = 0.3

r (IO) = 0.6

B blood type is found in people with the genotypes IBIB and IBIO.

Frequency of IBIB = q2 = 0.3 x 0.3 = 0.09

Frequency of IBIO = 2qr = 2 x 0.3 x 0.6 = 0.36

Frequency of B type = 0.09+0.36 = 0.45

This is an application question based on the Hardy-Weinberg equation mentioned on Page

29. (a) Each individual has two alleles. Each Rh-negative individual (dd) has two 'd' alleles. Each heterozygous Rh-positive individual (Dd) has one 'd' allele. Therefore

Frequency of recessive allele (q)

$$= \frac{2(\text{No.of 'dd' individuals}) + (\text{No .of 'Dd' individuals})}{2(\text{Total number of individuals})}$$

$$= \frac{2(360) = 240}{2(100)} = 0.48$$

30. (b) Theory of pangenesis was given by Darwin to explain the inheritance of characters from parents to off springs.

Haeckel gave a biogenetic Law stating "Ontogeny recapitulates phylogeny".

In modern synthetic theory, the unit of evolution is population Weismann's theory of germplasm rejected the Darwin's pangenesis theory.

Mutations are random and direction less i.e., they may result in loss or gain of characters.

31. (b)

32. (d) Higher mortality of large adult fish (compared to small adult fish) leads to decreased reproductive success of larger fish. The mean size of the fish body would gradually decrease over generations. This is directional selection which eliminates one extreme phenotype from an array of phenotypes.

33. (c) The cradle of human evolution is Africa. So, Homo sapiens arose in Africa and moved to different continents to develop into distinct races.

Agriculture came around 10,000 years ago, and human settlement started.

Modern Homo sapiens arose between 75000-10000 years ago Neanderthal man was present in central and eastern Asia between 100,000 -40,000 years back. It has a brain size of around 1400 CC.

34. (d) **35. (b)** **36. (d)**

Bio Blossoms

NEURAL CONTROL & COORDINATION

Introduction

The nervous system is the part of an animal that coordinates its actions by transmitting signals by nerve impulses, to and from different parts of its body.

The nervous system performs three basic functions; receives stimuli through sensory neurons from internal and external environment and passes to the brain; where the input stimuli is processed and then response is given back to the body parts through motor neurons.

Functional Unit of nervous system is neuron or nerve cell. Nervous system is absent in plant kingdom.

Nervous system in Animal kingdom

The nervous system evolved from a simple sting cell, nerve ganglion, and neurons to brain.

1. **Nervous system in protozoans:**
The protozoans lack nervous system.
2. **Nervous system in coelenterates:**
The coelenterates are multicellular organisms. The nerve net is the simplest form of a nervous system found in multicellular organisms. Unlike central nervous systems, where neurons are typically grouped together, neurons found in nerve nets are found spread apart. Hydra, which are cnidarians, have a nerve net throughout their body.

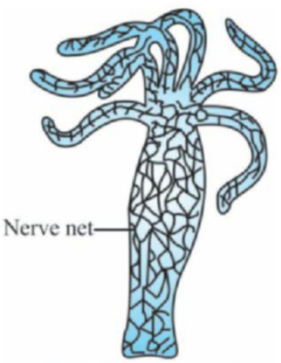


Fig: Hydra (cnidarian)

3. **Nervous system in Platyhelminthes:** They have a nerve net. The nervous system of the flatworm has an organisation different from the invertebrates described above. It does have a nerve net, but these are connected by long nerve cords. These cords are connected to cerebral ganglia located in the head region.

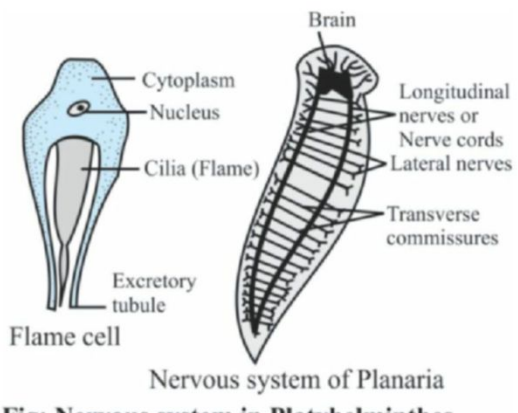


Fig: Nervous system in Platyhelminthes

5. **Nervous system in Nematodes:** Four peripheral nerves run the length of the body on the dorsal, ventral and lateral surfaces. The nervous system is also the only place in the nematode body that contains cilia, which are all non-motile and with a sensory function.

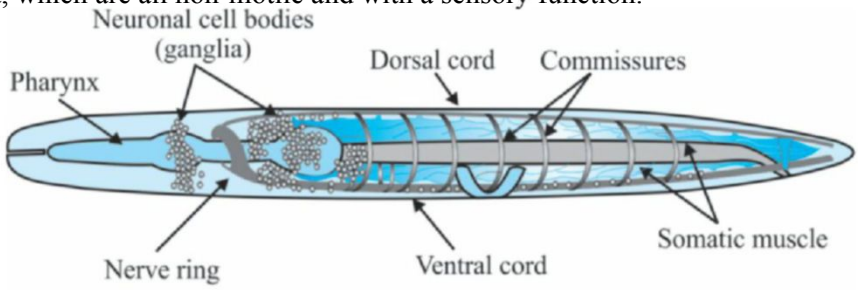


Fig: Nervous system in nematodes

4. **Nervous system in Molluscs:** Nervous system of snails, like that of all molluscs, is basically different from vertebrate nervous systems. Molluscs, with the exception of the most highly developed cephalopods, have no brain in the strict sense of the word. As a remainder of the rope ladder nervous system, most ganglia come in pairs.

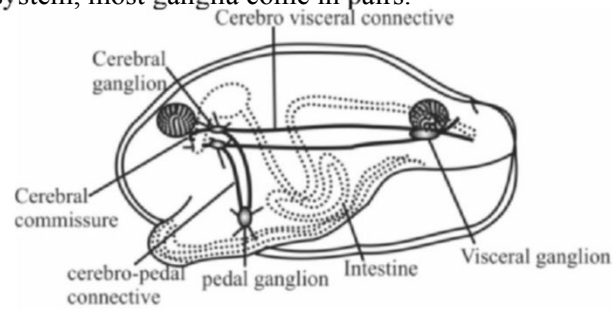


Fig: Nervous system in Mollusca (unio)

6. **Nervous system in Annelida:** The basic annelid nervous system consists of a single or double nerve cord running along the ventral side of the body with an enlarged region (ganglion) in each segment. Active annelids, such as the earthworm, have larger ganglia in the head region that serve as simple "brain".

The nerve cord originates at the head end of annelid worm, a region known as the cerebral ganglion - that's the annelid version of a brain.

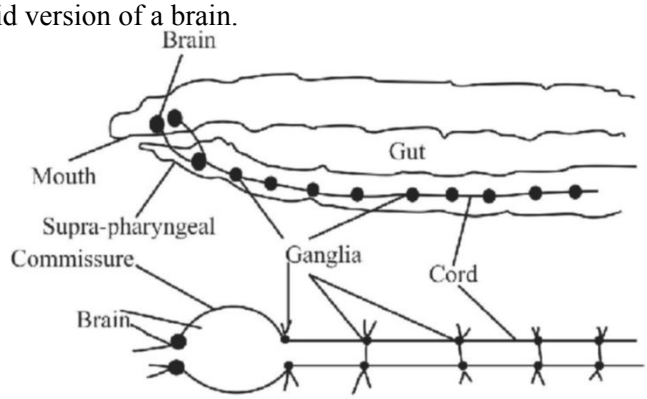


Fig: Nervous system in earthworm

7. Nervous System in arthropoda:

The arthropod nervous system consists of a dorsal brain and a ventral, ganglionated longitudinal nerve cord (primitively paired) from which lateral nerves extend in each segment. The system is similar to that of annelid worms, from which arthropods may have evolved.

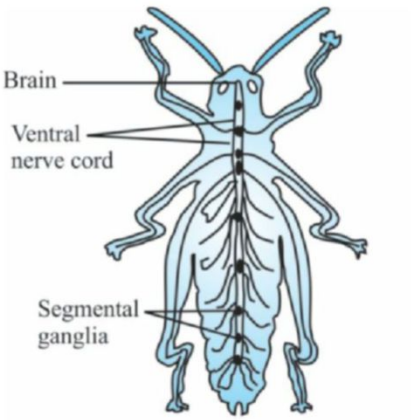


Fig: Nervous system in Anthropodan

8. Nervous System in Echinoderm: The echinoderm have a very simple nervous system, they lack a brain and many other common sensory organs, like eyes.

Echinoderms do not have a central brain. Echinoderms all have a network of nerves called nerve plexus. These nerves run intertwined under the surface of an Echinoderm's skin.

Although the echinoderms do not have many well-defined sensory inputs, they are sensitive to touch, light, temperature, orientation and the status of water around them.

Sense is caused by sensitivity in the tube feet of Echinoderms which line the undersides of their bodies and eye spots located throughout the body. The eye spots each consist of a mass of oculi, consisting of pigmented epithelial cells that respond to light intensity, and are lined with sensory cells in between them. Each oculus is covered by a cuticle that both protects them through its thickness and acts as a lens with its transparency.

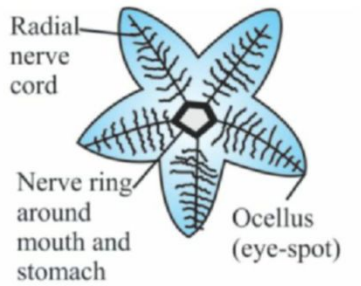


Fig: Nervous system in Asterias

9. Nervous System in chordates: Dorsal nerve cord is another feature the chordates share. This is a hollow nerve cord that is towards the back compared to the notochord. In animals that have a backbone (vertebrates) this dorsal nerve cord becomes the brain and spinal cord.

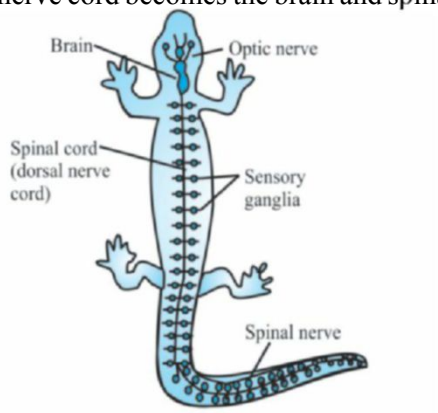


Fig: Nervous system in chordates-reptiles

Function of Nervous system:

1. The stimuli or impulses are carried to CNS from muscles and vice versa.
2. Co-ordinates various organ systems.
3. It stimulates and inhibits the activities of muscles, glands and viscera.
4. It helps to maintain the homeostatic condition.
5. Forms and retains memory.
6. Conducts information and message.

Human nervous system

The study of nervous system is called neurology.

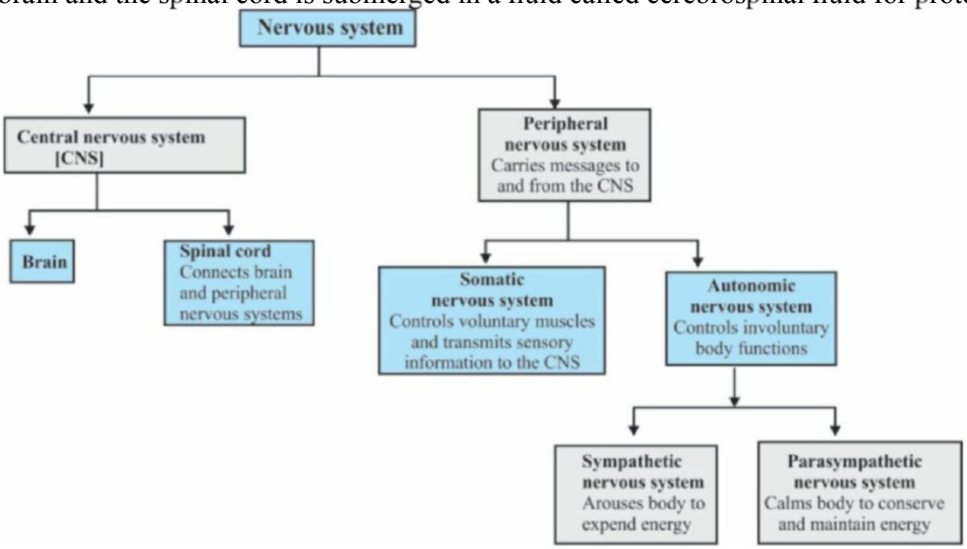
Human nervous system is broadly divided into central nervous system and peripheral nervous system.

1. The central nervous system consists of brain and spinal cord.
2. The peripheral nervous system consists of sensory and motor nerves. Motor nerves are further divided into anotomous nervous system and somatic nervous system.
3. The anotomous nervous system works independently to regulate smooth muscles, cardiac muscles and glands.

The central nervous system:

The central nervous system is made up of brain and spinal cord.

The brain and the spinal cord is submerged in a fluid called cerebrospinal fluid for protection.



The CSF: About 150cc of cerebrospinal fluid is present in an adult. It is secreted from anterior and posterior choroids plexus. Total volume of CSF is 150ml. The rate of formation is 20ml/hr. CSF can be obtained by lumber puncture. It consists of salts, glucose, and small amount of albumin, globulin and few traces of urea and creatinine. It is secreted by anterior and posterior choroid plexus in ventricles of brain, central canal of spinal cord and space around the brain and spinal cord. It performs following functions.

1. Acts as cushion shock absorber.
2. Acts as medium for exchange of different materials through the blood vessels.
3. Keeps the brain and spinal cord moist and exchange of substances between CSF and nerve cells.
4. It makes the brain weight less through buoyancy. It maintains uniform pressure around these delicate structures.
5. It nourishes the nerve cells and also acts as buffer.

The main component of the brain and spinal cord is the nerve cells or the neurons.

Neuron structure & classification Structure:

A neuron is an electrically excitable cell that processes and transmits information through electrical and chemical signals. Neurons are the major components of the brain and spinal cord of the central nervous system (CNS), and of the autonomic ganglia of the peripheral nervous system.

A neuron is a microscopic structure composed of three major parts, namely, cell body, dendrites and axon.

Cell Body: The cell body contains cytoplasm with typical cell organelles and certain granular bodies called Nissl's granules.

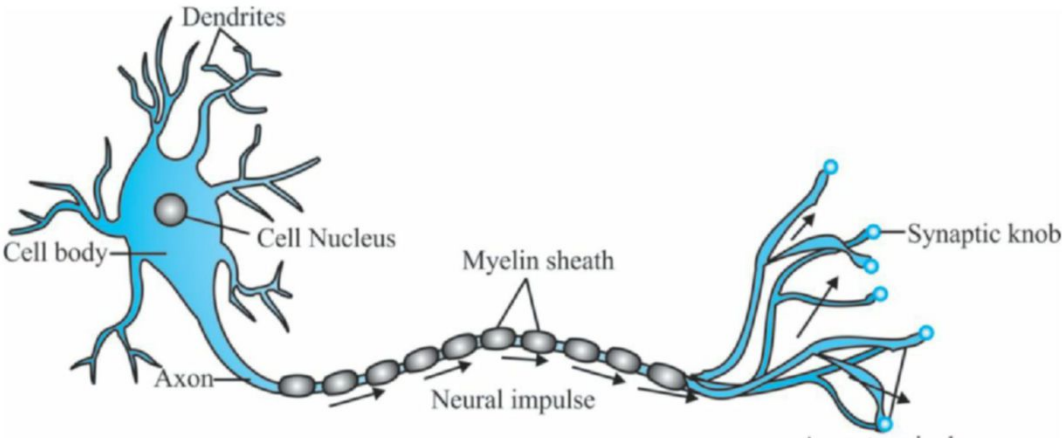


Fig: Neuron-structure

Dendrites: Short fibres which branch repeatedly and project out of the cell body also contain Nissl's granules and are called dendrites. These fibres transmit impulses towards the cell body.

Axon: The axon is a long fibre, the distal end of which is branched. Each branch terminates as a bulb-like structure called synaptic knob which possess synaptic vesicles containing chemicals called neurotransmitters. The axons transmit nerve impulses away from the cell body to a synapse or to a neuro-muscular junction.

Classification of Neurons:

I. Based on the number of axon and dendrites, the neurons are divided into three types:

(a) Multipolar (with one axon and two or more dendrites; found in the cerebral cortex),
Golgi I: neurons with long-projecting axonal processes; examples are pyramidal cells, purkinje cells and anterior horn cells.
Golgi II: neurons whose axonal process projects locally; the best example is the granule cell.

(b) Bipolar (with one axon and one dendrite, found in the retina of eye) and

(c) Unipolar (cell body with one axon only; found usually in the embryonic stage).

(d) Anaxonic where axon cannot be distinguished from dendrites.

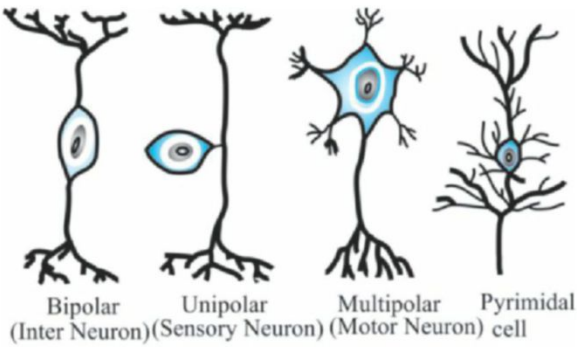


Fig: Basic Neuron Types

II. Classification based on myelinated sheath:
There are two types of axons, namely, myelinated and non-myelinated.

(a) The myelinated nerve fibres are enveloped with Schwann cells, which form a myelin sheath around the axon. The gaps between two adjacent myelin sheaths are called nodes of Ranvier. Myelinated nerve fibres are found in spinal and cranial nerves.

(b) Non- myelinated nerve fibre is enclosed by a Schwann cell that does not form a myelin sheath around the axon, and is commonly found in autonomous and the somatic nervous systems.

III.Functional classification:

(a) Afferent neurons convey information from tissues and organs into the central nervous system and are also called sensory neurons.

(b) Efferent neurons transmit signals from the central nervous system to the effector cells

and are also called motor neurons.

(c) Interneurons connect neurons within specific regions of the central nervous system.

Afferent and efferent also refer generally to neurons that, respectively, bring information to or send information from the brain.

Conduction of nerve impulse Across Neuron

(a) Resting potential: The permeability of plasma membrane to K^+ ions is greater than its permeability to Na^+ ions. So the surface of axon carries a positive charge relative to its interior; this electrical potential difference across the plasma membrane is called resting potential and it ranges from – 40 to – 90 mV.

(b) Action potential: When a threshold stimulus is applied on the axon membrane, depolarisation is caused by a rapid change in membrane permeability. The membrane becomes more permeable to Na^+ than to K^+. The interior becomes electropositive and the ECF becomes electronegative. The depolarisation spreads, producing a local current, which induces the nearby passive Na^+ channels to open and to depolarise the nearby site.

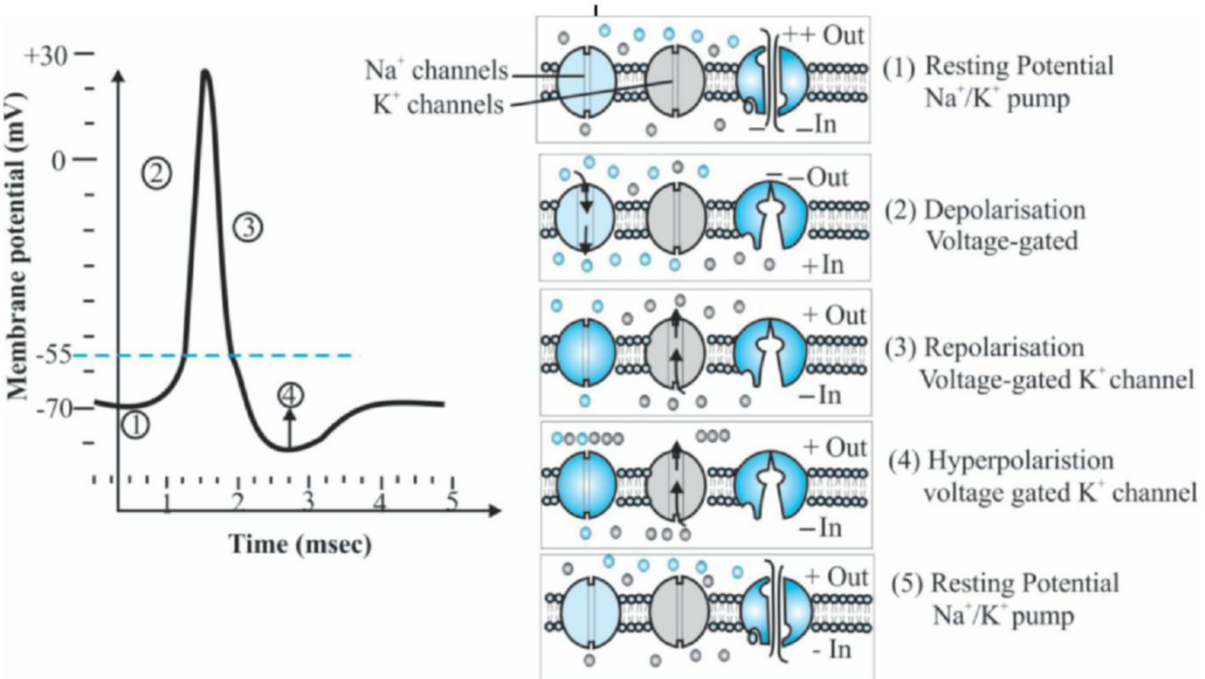
(c) Repolarisation: After about 0.5 ms, permeability to K^+ ion increases because the build-up of positive charge inside the cell opens the voltage gated K^+ channels. Movement of K^+ ions outward, down their concentration gradient, then re-establishes the charge differences that existed before the stimulus occurred.

(d) Hyperpolarisation: However K^+ ion channels remain open for a bit longer period so that the membrane potential becomes more negative than -70 mv. It is called hyperpolarisation. It takes about 1-5m sec for repolarisation.

The exodus of K^+ ions lowers the number of positive ions within the cell and the potential falls back towards the resting potential.

Functions Of Neuron:

Neurons (nerve cells) have three parts that carry out the functions of communication and integration: dendrites, axons, and axon terminals. They have a fourth part the cell body or soma, which carries out the basic life processes of neurons.



Conduction of nerve impulse Across synapse

In a synapse, there is a narrow fluid-filled gap of 10-20 nm, called synaptic cleft. The nerve terminal has a bulbous expansion called synaptic knob or synaptic button.

In the cytoplasm of the synaptic knob, numerous tiny membrane-bound synaptic vesicles are present. These synaptic vesicles contain as many as 10,000 molecules of the neurotransmitter. When a nerve impulse reaches the presynaptic membrane, the voltage-gated calcium channels concentrated in the synapse, open.

Calcium ions from the fluid in the synapse diffuse into the synaptic button and stimulate the vesicles to move to the terminal membrane, fuse with it and then rupture to release the neurotransmitter.

The neurotransmitters quickly diffuse to the other side of the gap, combine with specific receptor molecules of the other nerve cell and cause sparking a second electrical current, passing its signal.

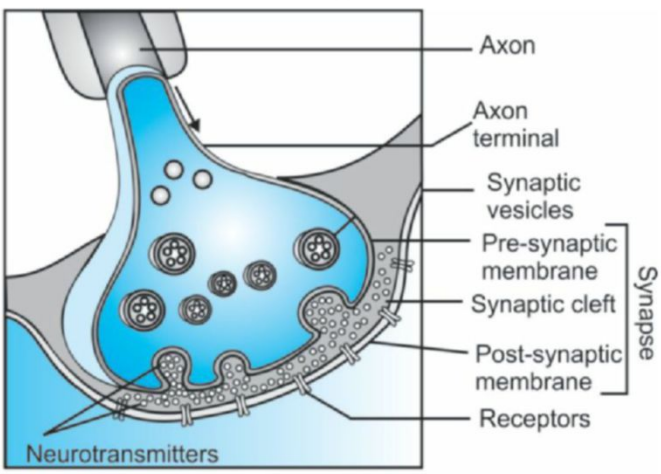


Fig: Diagram showing axon terminal and synapse

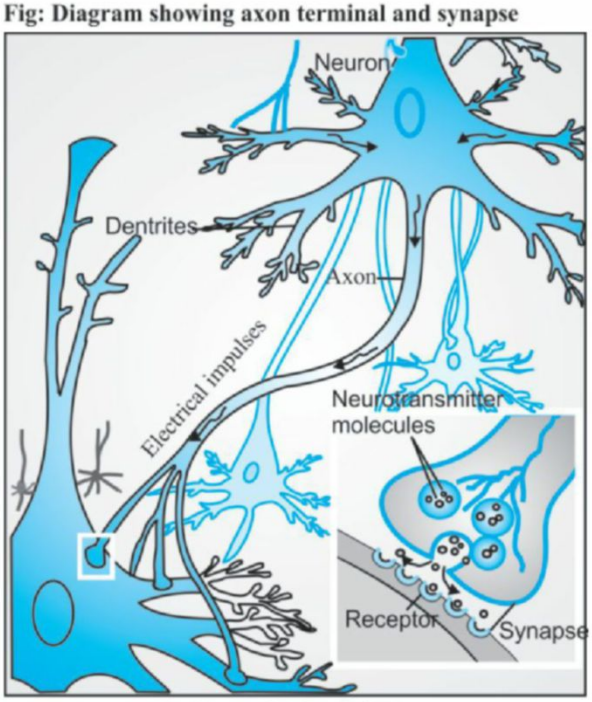


Fig: Synaptic Transmission

The Brain

Brain is a highly specialised delicate organ located in skull or cranium. It is about 1.4 kg. Brain is covered by three layers known as meninges.

1. Outer layer is duramater -It is just located below the skull. It is highly vascular tough white fibrous tissue. It supports the brain and spinal cord.
2. Middle layer is arachnoid -It is the middle, delicate and thin fibrous covering below the subdural cavity.
3. Inner layer piamater -It is thin delicate and highly vascular innermost layer. It is separated from arachnoid membrane by a subarachnoid space. The space is filled with spongy connective tissue and cerebrospinal fluid (CSF).

A deep cleft called longitudinal fissure divides the brain into two halves or the cerebrum into right and left hemispheres.

Human brain is covered by a tough tissue covering called meninges and is mainly divided into forebrain, midbrain and hindbrain.

1. **Forebrain:** also known as prosencephalon, having the following parts.
   - **I.** Cerebrum – right and left hemispheres separated by longitudinal fissure.
   - **II.** Cerebral cortex
   - **III.** Basal ganglia
   - **IV.** The limbic system
   - **V.** The diencephalon having Thalamus, Hypothalamus and Epithalamus
2. **Mid Brain:** called mesencephalon reflexes centre of visual and auditory sensation.
3. **Hind-Brain:** also called rhombencephalon
   I. Cerebellum **II.** Pons
   III. Medulla oblongata

Forebrain:

I. Cerebrum:

1. It contains two cerebral hemispheres, right and left separated by a longitudinal fissure, internally connected by corpus callosum.
2. Four lobes are present named after the bones guarding them. Frontal, parietal, temporal and occipital lobe.
3. Three pairs of bundles of myelinated nerve fibres called Cerebellar Peduncles form the communication pathways between the Cerebellum and other parts of the CNS.
   - Superior Cerebellar peduncles – connect the cerebellum to the midbrain.
   - Middle Cerebellar peduncles – have connection with Pons of Hind brain.
   - Inferior Cerebellar peduncles – communicate with medulla oblongata and spinal cord.
4. There are different areas on the cerebrum. These are-Motor area for movement, sensory area for heat, cold, light, pressure, touch, auditory area for hearing, visual area for seeing, olfactory area for smell and taste area for taste. Each hemisphere receives information from opposite side of the body. Cavity of each cerebral hemisphere is called lateral ventricles.
5. Wernicke's area is known to be important for the interpretation of language and the formulation of thought into speech.
6. Functions-
   (a) It controls all mental and conscious activities (such as intelligence, memory, reason, will, feelings and emotions).
   (b) It is the site of originator of voluntary acts and interpreter of sensations.
   (c) It is a control centre of reflex actions.

II. Cerebral Cortex:

1. This accounts to about 80% of the total brain weight. These are made of continuous folds or convolutions, with their raised parts called gyri and depressions are called sulci.
2. The cerebral cortex is referred to as the grey matter due to its greyish appearance. The neuron cell bodies are concentrated here giving the colour.
3. Fibres of the tracts are covered with the myelin sheath, which constitute the inner part of cerebral hemisphere. They give an opaque white appearance to the layer and, hence, is called the white matter.
4. The cerebral cortex contains motor areas, sensory areas and large regions that are neither clearly sensory nor motor in function.

These regions called as the association areas are responsible for complex functions like intercessory associations, memory and communication.

III.Basal Ganglia:

1. The basal ganglia (or basal nuclei) is a group of subcortical nuclei, of varied origin, in the brains of vertebrates.
2. The basal ganglia form a fundamental component of the cerebrum. In contrast to the cortical layer that lines the surface of the forebrain, the basal ganglia are a collection of distinct masses of grey matter lying deep in the brain not far from the junction of the thalamus.
3. Basal ganglia nuclei are strongly interconnected with the cerebral cortex, thalamus, and brainstem, as well as several other brain areas.
4. The basal ganglia are associated with a variety of functions including: control of voluntary motor movements, procedural learning, routine behaviours or "habits" such as teeth grinding, eye movements, cognition and emotion.

IV. The Limbic System:

1. The inner parts of cerebral hemispheres and a group of associated deep structures like amygdala and hippocampus to form a complex structure called the limbic lobe or limbic system.
2. It is a part, which connects cerebrum and the brain stem. It sends signals to brain and body parts to regulate our behaviour.

   a. Amygdala: It is located above the hypothalamus and influences behaviour and activities so that they are appropriate for meeting the body's internal needs. These include feeding, sexual interest, and emotional reactions such as anger. Hence it is responsible for controlling our moods.

   b. Hippocampus: It is the swollen lower lip of the limbic fork. It involves with learning, the recognition and memory. It also converts short term memory to long term memory; hence it plays a vital role in learning.
3. **Septum:** It is a part of hypothalamus has centre for sexual arousal.

V. The Diencephalon: consists of three major parts:

1. **Thalamus:** contains many different nuclei, each one dedicated to sensory information of a particular type. Incoming information from all the senses is sorted out in the thalamus and sent on to the appropriate higher brain centres for further interpretation and indignation. It also receives input from the cerebrum and from parts of the brain that regulate emotion and arousal, making it an important station for controlling access to the cerebrum.
2. **The hypothalamus:** lies below the thalamus and regulates functions, such as body temperature, sexual drive, carbohydrate metabolism, hunger, and thirst. (Hypothalamus is the source of two sets of hormones, posterior pituitary hormones and releasing hormones of the anterior pituitary). Part of hypothalamus called suprachiasmatic nucleus, functions as our biological clock.
3. **The epithalamus:** small resign present superior and anterior to the thalamus. Consists of pineal gland-secreting melatonin, and habernular nuclei- olfaction especially emotional responses to odour.

Mid Brain:

The midbrain contains 4 little lobes called Corpora Quadrigemina. It has a pair of Superior colliculi controls visual reflexes (to fix and focus on an object) and a pair of Inferior colliculi controls auditory reflexes (locates and detects the source of a sound).

Hind Brain:

I. Cerebellum:

1. Called the second cerebrum, contributes to 10% of the brain weight and about 50% of the total neurons.
2. The cerebellum plays an important role in motor control, and it may also be involved in some cognitive functions such as attention and language as well as in regulating fear and pleasure responses, but its movement-related functions are the most solidly established.

3. It does not initiate movement, but contributes to coordination, precision, and accurate timing. It receives input from sensory systems of the spinal cord and from other parts of the brain, and integrates these inputs to fine-tune motor activity.
4. Cerebellar damage produces disorders in fine movement, equilibrium, posture, and motor learning in humans.
5. Cerebral cortex called grey matter is on the outside, comprising of three layers of cells. Within this thin layer are several types of neurons with a highly regular arrangement, the most important being Purkinje cells and granule cells and the white matter lies inside.
6. **Functions:** (a) It co-ordinates muscular body movement.
   (b) It controls reflex action of skeletal muscle activities.

II. Pons Varolii:

1. It is situated in front of cerebellum and above the medulla oblongata and joins medulla oblongata with the mid brain. Its fibre is of white matter.
2. This region of the brainstem includes neural pathways or tracts that conduct signals from the brain down to the cerebellum and medulla, and tracts that carry the sensory signals up into the thalamus.
3. The pons in humans measures about 2.5 centimetres (0.98 in) in length. Most of it appears as a broad anterior bulge rostral to the medulla. Posteriorly, it consists mainly of two pairs of thick stalks called cerebellar peduncles. They connect the cerebellum to the pons and midbrain.
4. The pons contains nuclei that relay signals from the forebrain to the cerebellum, along with nuclei that deal primarily with sleep, respiration, swallowing, bladder control, hearing, equilibrium, taste, eye movement, facial expressions, facial sensation and posture.

III. Medulla Oblongata:

1. It is the posteriormost part and connects the spinal cord and various parts of the brain.
2. The medulla of the brain is connected to the spinal cord. The medulla contains centres which control respiration, cardiovascular reflexes and gastric secretions.
3. This brain stem controls various reflexes like breathing, salivation, chewing, coughing, sneezing, etc.

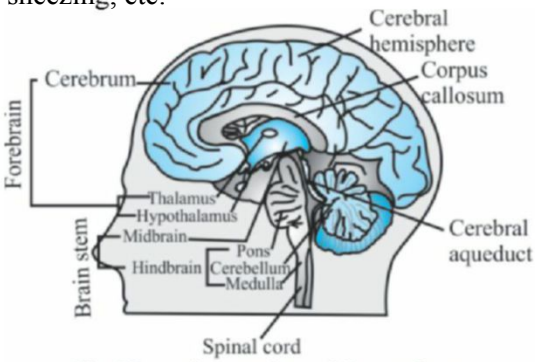


Fig: The major portions of the cerebrum, cerebellum and brain stem

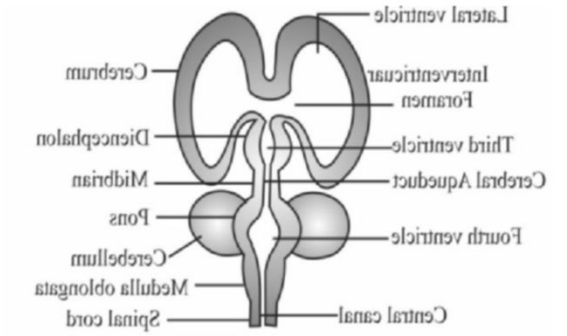


Fig: Schematic representation of the ventricles of Human brian

Ventricles of the Brian and Cerebrospinal Fluid

The ventricles consist of four hollows, fluid filled spaces inside the brain. A lateral ventricle lies inside each hemisphere of the cerebrum. Each lateral ventricle is connected to the third ventricle by an interventricular Foramen (formen of Monro). The third ventricle consists of a narrow channel between the hemispheres through the area of the thalamus. It is connected by the cerebral aqueduct or aqueduct of sylvius or iter in the midbrian portion of the brain stem to the fourth

ventricle in the pons and medulla. The fourth ventricle continues with the central canal of the spinal cord. Three openings in the roof of the fourth ventricle, a pair continues with the central canal of the spinal cord. Three openings in the roof of the fourth ventricle, a pair of lateral apertures (foramina of luschka) and a median aperture (foramen of Magendie) allow cerebrospinal fluid to move upward to the subarachnoid space that surrounds the brian and spinal cord.

The cerebrospinal fluid is secreted by anterior choroid plexus and posterior choroid plexus and is found inside the ventricles of the brain, the central canal of the spinal cord. The cerebrospinal fluid acts as a shock absorber for the brain and spinal cord and may also nourish brian tissue. It contains protein, glucose, chloride and water.

The spinal cord

1. It is a posterior part of CNS which runs mid dorsally within the vertebral column. It is elongated, almost cylindrical part. It extends from the medulla oblongata within vertebral column to the level of second lumber vertebra.
2. 42-45 cm long and 2 cm thick (in mid thoracic region) and longer in lower cervical and lumbar regions. It grows till 4-5 yrs. It acts like a link between brain and various parts of the body.
3. Internally, spinal cord is divided into left and right symmetrical halves. Posterior is median sulcus and anterior is median fissure. There is a central canal surrounded by a butterfly shaped area of grey matter. Around the grey matter there is white matter.
4. Grey matter is H-shaped with two dorsal and ventral horns. Roots of spinal nerve are originated from the horns.
5. There are 31 pairs of spinal nerves that arise from different segments of spinal cords. Each spinal nerve carries both sensory and motor impulses. Each spinal nerve connects with nerve roots.

Dorsal nerve root: It originates from the dorsal horn of grey matter. It consists of only sensory fibres. It bears the dorsal root ganglion containing only sensory cells.

Ventral nerve root: It originates from the ventral horn of grey matter. It is made up of only motor fibres. It does not bear ganglion.

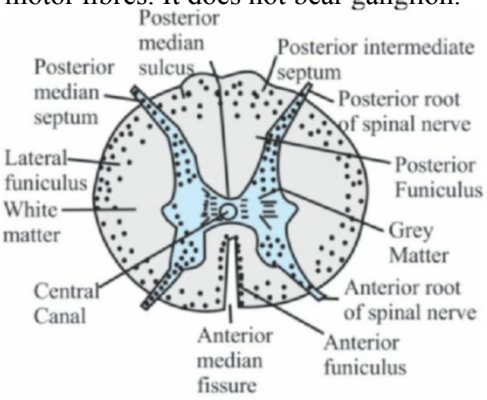


Fig: Spinal cord

No.	Cranial nerve	Types of fight	Organs innervated	Function
I	Olfactory nerve	Sensory	Mucosa in nose	Smell
II	Optic nerve	Sensory	Retina of eye	Vision
III	Occulomotor nerve	Motor	Eye muscles, Ciliary muscles	Eye movement, accommodation
IV	Trochlear nerve	Motor	Superior oblique muscles of eye ball	Eye movement
V	Trigeminal nerve	Mixed	Skin teeth, mucosal membrane of mouth	Sensation head, face
VI	Abducens nerve	Motor	Eyeball muscles	Eyeball movement
VII	Facial nerve	Mixed	Taste buds, salivary glands, facial and neck muscles	Facial expression, saliva secretion, taste
VIII	Auditory nerve	Sensory	Internal ear	Equilibrium, Hearing
IX	Glossapharyngeal	Mixed	Pharynx, tongue, salivary glands	Taste, swallowing and saliva secretions
X	Vagus nerve	Mixed	Pharynx to viscera	Visceral reflexes
XI	Spinal accessory	Motor	Thoracic and abdominal viscera	Visceral reflexes, Shoulder movement
XII	Hypoglossal nerve	Motor	Muscles of tongue	Movement

Peripheral Nervous System:

The nervous system outside the brain and spinal cord.The PNS consists of the nerves and ganglia outside the brain and spinal cord. CNS and PNS communicate with each other to make sure our body parts, such as our fingers, can send signals to the central nervous system for processing in our brains.

The peripheral nervous system includes all the nerves that go from the skin, muscle, and organs to the spinal cord and eventually the brain. However, the central nervous system is composed of the brain and spinal cord.

The peripheral nervous system consists of 12 pairs of cranial nerves and 31 pairs of spinal nerves.

I. Cranial nerves:

12 pairs – 10 pairs originate from brain stem.

There are 3 types of CN sensory nerves (sensory fibres), mixed nerves (has both) and motornerves (motor fibres).

II. Spinal Nerves:

All the spinal nerves are mixed nerves.

Each spinal nerve has two roots, a dorsal sensory and a ventral motor root.

At the middle of each dorsal root, is a swelling called dorsal root ganglion, which contains sensory neurons.

The motor neurons for the ventral root are present in the grey matter of spinal cord.

These nerves are:

Cervical = 8 pair in neck

Thoracic = 12 pair in thorax

Lumbar = 5 pair in upper abdomen

Sacral = 5 pair in lower abdomen

Coccygeal = 1 pair in tail region

Total spinal fibers = 31 pairs

So the spinal formula is $C_8\ Th_{12}\ L_5\ S_5\ Co_1$

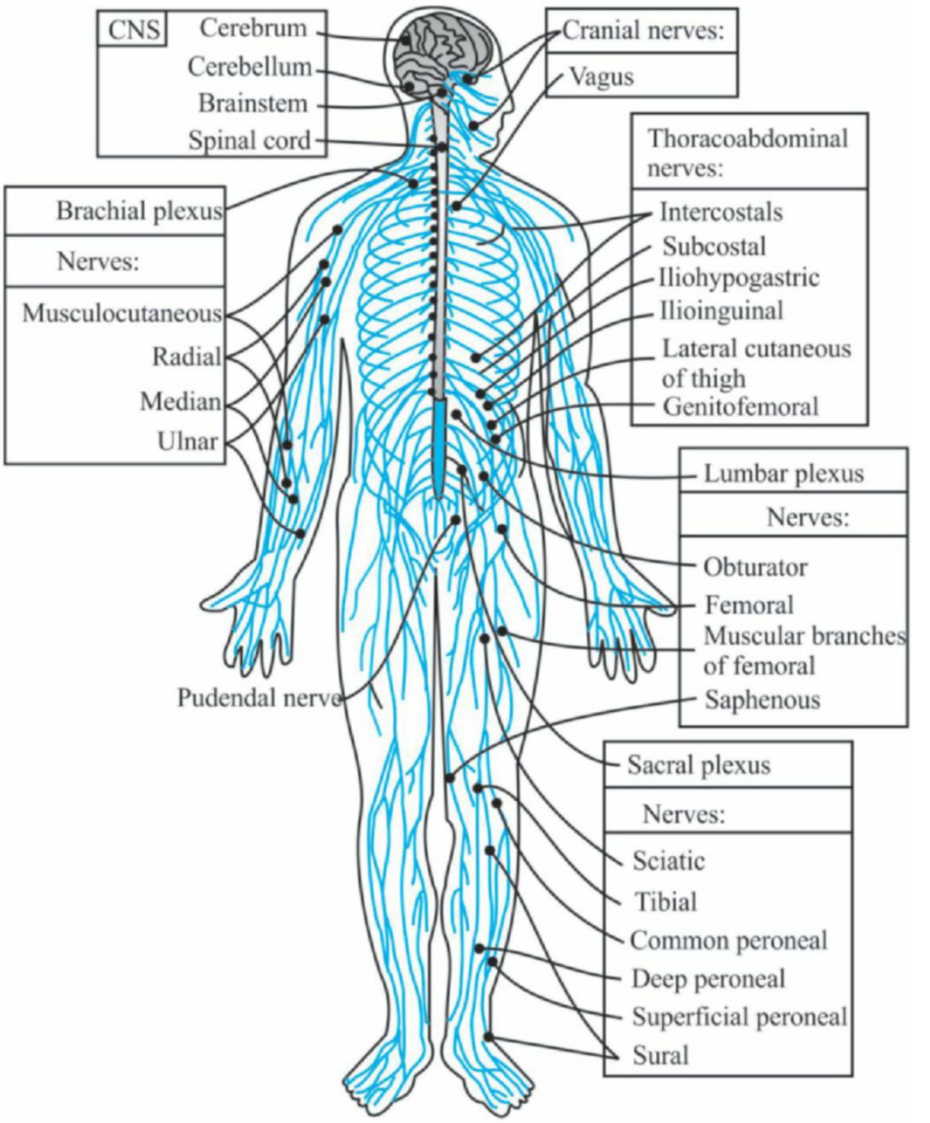


Fig: Peripheral neural system

Autonomic Nervous System (ANS):

Autonomic nervous system controls and co-ordinates the various activities of visceral organs. Hence it is also called visceral nervous system. Actually ANS is not autonomous or independent because it is regulated by higher nerve centre of brain. It consists of two antagonistic (opposite in function) system.

It acts unconsciously to great extent and regulates bodily functions such as the heart rate, digestion, respiratory rate, pupillary response, urination, and sexual arousal.

It has two main divisions- sympathetic and parasympathetic nervous system.

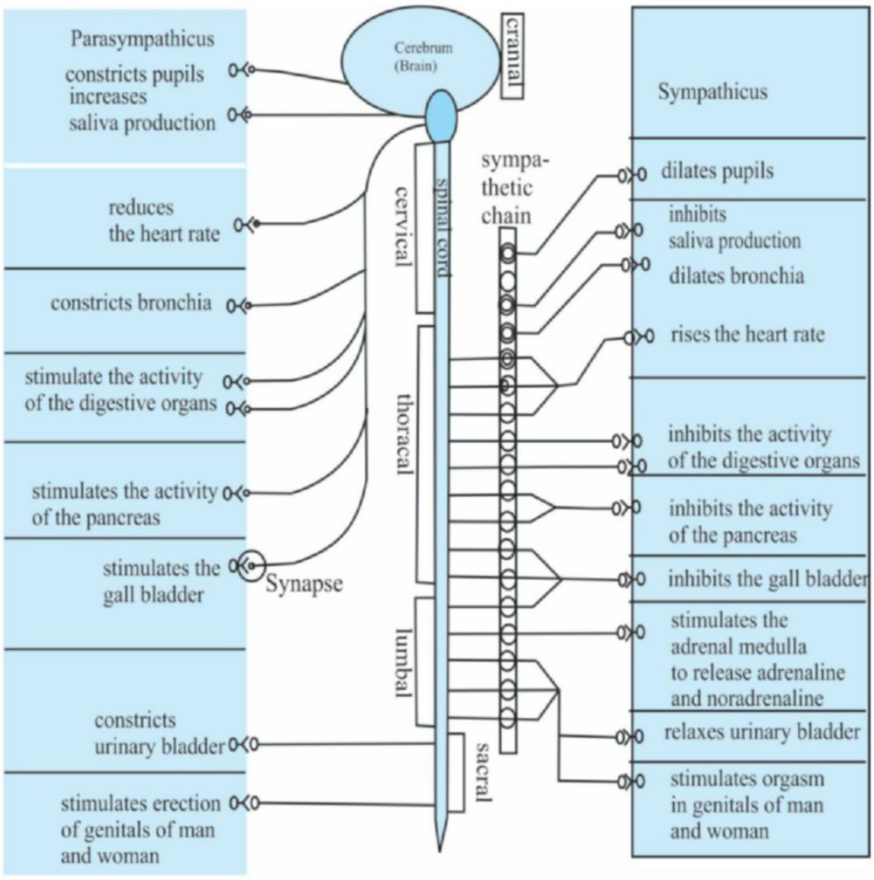


Fig: Response to stimulus

Response To Stimulus:

Stimulus: Stimulus is a sudden change in the external or internal environment, which excite the nerve or organism or muscle as whole. The stimulus which is capable to just excite given tissue is called threshold stimulus.

There are many types of stimuli which can excite the tissue:

a. Mechanical stimuli: These include touch muscular stress etc.

b. Physical stimuli: These include heat and humidity.

c. Chemical stimuli: The electrical stimuli is able to excite tissue.

Synapse:

Synapse is an area of functional contact between one neuron and another to transfer information. Synapses are usually found between the fine terminal branches of the axon of a neuron and the dendrites or cell body of another.

Reflex Action And Reflex Arc:

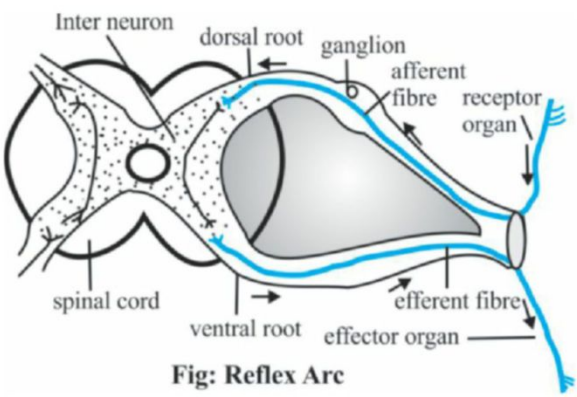


Fig: Reflex Arc

Reflex actions are very rapid, involuntary automatic and stereotyped behaviour, in which

some stimulus evoke a specific, short-lived response at the unconscious level. There are more than two hundred reflexes, which follow the sequence from stimulus to reflex, along a neural pathway called reflex arc.

The reflex pathway comprises at least one afferent neuron (receptor) and one efferent (effector or excitor) neuron appropriately arranged in a series. The afferent neuron receives signal from a sensory organ and transmits the impulse via a dorsal nerve root into the CNS (at the level of spinal cord). The efferent neuron then carries signals from CNS to the effector. The stimulus and response thus form a reflex arc as shown below in the knee jerk reflex.

Sensory Reception And Processing:

Sense organ is the one which responds to external stimuli by conveying impulses to the sensory nervous system.

Sense organs are specific for one kind of stimulus. They transform the received stimulus into nerve impulses. They are the biological transductors.

Sense	Stimulus	Sense organ	Receptor	Sensation
Sight	Light waves	Eye	Rods and cones of retina	Colors, Patterns, textures, motion, depth in space
Hearing	Sound waves	Ear	Hair cells located in inner ear	Noise, tones
Skin sensation	External contact	Skin	Nerve endings in skin	Touch, pain, warmth, cold
Smell	Volatile substances	Nose	Hair cells of olfactory membrane	Odours (musky, flowery, burnt, minty)
Taste	Soluble substances	Tongue	Taste buds of tongue	Flavours (sweet, sour, salty,bitter)
Vestibular sense	Mechanical and gravitational forces	Inner ear	Hair cells of semicircular canals and vestibule	Spatial movement, gravitational pull
Kinesthesis	Body movement	Muscles, tendons	Nerve fibres in muscles, tendons and joints	Movement and position of body parts

Eye:

Eyes are organs of the visual system. They provide organism's vision, the ability to process visual detail, as well as enabling several photo response functions that are independent of vision.

Eyes detect light and convert it into electro-chemical impulses in neurons. In higher organisms, the eye is a complex optical system which collects light from the surrounding environment, regulates its intensity through a diaphragm, focuses it through an adjustable assembly of lenses to form an image, converts this image into a set of electrical signals, and transmits these signals to the brain through complex neural pathways that connect the eye via the optic nerve to the visual cortex and other areas of the brain.

Eye Structure:

The human eye is a complex optic instrument. Its main goal is to "transfer" the correct image to the optic nerve.

Cornea:

It is a transparent coat covering the front part of the eye. It has no blood vessels, but its refraction is great. It is part of the eye optic. Cornea borders sclera which is a non-transparent eye coat.

Anterior chamber:

It is a space between cornea and iris. It is filled with intra-ocular fluid.

Iris looks like a circle with an opening in

the middle (pupil). Iris consist of muscles that change pupil size by constricting and relaxing. IT is a part of the eye choroid. Iris is responsible for the colour of the eyes (if it is blue this means it contains few pigment cell, if brown – a lot). Its function is same as of aperture in a camera – to adjust light flow. Pupil is an aperture in iris. Its size usually depends on the illumination level. The more light the smaller the pupil.

Crystalline lens:

It is the eye "natural lens'. It is transparent, elastic – can change its shape, focusing in almost instantly, therefore one can see well both near and far. It is located in a capsule and is withheld by ciliary zonule. The crystalline lens like cornea is a part of the eye optic.

Vitreous body:

It is a gel-like transparent substance located in the posterior part of the eye. The vitreous body supports the sphere of the eyeball and is part of the intraocular metabolism. It is a part of the optic system.

Retina:

It consists of photoreceptors (light sensing) and nerve (ganglion) cells. There are two types of receptor (transducer) cells in retina: cones and rods. These cells producing rhodopsin enzyme transform light energy (photons) into electric energy of neural tissue, i.e., photochemical reaction takes place.

Rods have high light sensitivity and allow seeing in poor light, they are also responsible for periphery vision. Cones adversely need plenty of light for functioning but allow to distinguish small details (responsible for direct vision) and ensure colour appreciation. Most cones are located in macula which is responsible for the sharpest vision. Retina adjoins choroid but not too snug in some areas. It is here that it may detach under various retina diseases.

Sclera:

It is the non-transparent outer coat of the eye bulb and in the frontal part of the eye it verges into the transparent cornea. 6 eye moving muscles are attached to it. It contains a few nerve terminals and vessels.

Choroid:

It inlays the back part of sclera, it adjoins retina and is closely linked to it. Choroid is responsible for blood supply of intraocular structures. And with retina disorders it is usually involved in the pathology process. Choroid has no nerve terminals therefore when there is a trouble there, there is no pain which usually alarms about a problem.

Optic nerve:

It transfers signals from nerve terminals to the brain.

The orbit is the bony cavity that contains the eyeball, muscles, nerves, and blood vessels, as well as the structures that produce and drain tears. Each orbit is a pear-shaped structure that is formed by several bones.

The outer covering of the eyeball consists of a relatively tough, white layer called the sclera (or white of the eye). Near the front of the eye, in the area protected by the eyelids, the sclera is covered by a thin, transparent membrane (conjunctiva), which runs to the edge of the cornea.

The conjunctiva also covers the moist back surface of the eyelids and eyeballs.

Light enters the eye through the cornea, the clear, curved layer in front of the iris and pupil. The cornea serves as a protective covering for the front of the eye and also helps focus light on the retina at the back of the eye. After passing through the cornea, light travels through the pupil (the black dot in the middle of the eye).

The iris—the circular, colour area of the eye that surrounds the pupil—controls the amount of light that enters the eye. The pupil dilates (enlarges) and constricts (shrinks) like the aperture of a camera lens as the amount of light in the immediate surroundings changes. The iris allows amount of light into the eye when the environment is dark and allows less light

into the eye when the environment is bright. The size of the pupil is controlled by the action of the pupillary sphincter muscle and dilator muscle.

Behind the iris sits the lens. By changing its shape, the lens focuses light onto the retina. Through the action of small muscles (called the ciliary muscles), the lens becomes thicker to focus on nearby objects and thinner to focus on distant objects.

The retina contains the cells that sense light (photoreceptors) and the blood vessels that nourish them. The most sensitive part of the retina is a small area called the macula, which has millions of tightly packed photoreceptors (the type called cones). The high density of cones in the macula makes the visual image detailed, just as a high-resolution digital camera has more megapixels. Each photoreceptor is linked to a nerve fibre. The nerve fibres from the photoreceptors are bundled together to form the optic nerve. The optic disc, the first part of the optic nerve, is at the back of the eye. The photoreceptors in the retina convert the image into electrical signals, which are carried to the brain by the optic nerve.

There are two main types of photoreceptors: cones and rods. Cones are responsible for sharp, detailed central vision and colour vision and are clustered mainly in the macula. The rods are responsible for night and peripheral (side) vision. Rods are more numerous than cones and much more sensitive to light, but they do not register colour or contribute to detailed central vision as the cones do. Rods are grouped mainly in the peripheral areas of the retina.

The eyeball is divided into two sections, each of which is filled with fluid. The front section (anterior segment) extends from the inside of the cornea to the front surface of the lens. It is filled with a fluid called the aqueous humour, which nourishes the internal structures. The back section (posterior segment) extends from the back surface of the lens to the retina. It contains a jelly-like fluid called the vitreous humour. The pressure generated by these fluids fills out the eyeball and helps maintain its shape.

The anterior segment is divided into two chambers. The front (anterior) chamber extends from the cornea to the iris. The back (posterior) chamber extends from the iris to the lens. Normally, the aqueous humour is produced in the posterior chamber, flows slowly through the pupil into the anterior chamber, and then drains out of the eyeball through outflow channels located where the iris meets the cornea.

Basic eye function:

1. Optic system projecting an image;
2. System that perceives and "encodes" the received information for the brain;
3. Life supporting "servicing" system.

Mechanism of Vision:

The light rays pass through cornea, aqueous humour, lens and vitreous humour and focus on retina where they generate potentials (impules) in rods and cones.

The photosensitive compounds (photopigments) in the human eyes are composed of opsin (a protein) light induces dissociation of retinal from opsin which changes the structure of the opsin. Thus potential differences are generated in photoreceptor cells. This causes action potential impulse in the ganglion cells through the Bipolar cells.

The impluses are transmitted by the optic nerves to the visual cortex area in the Occipital lobe of the cerebral hemisphere of the brain where the neural impluses are analysed and erect image is recognised.

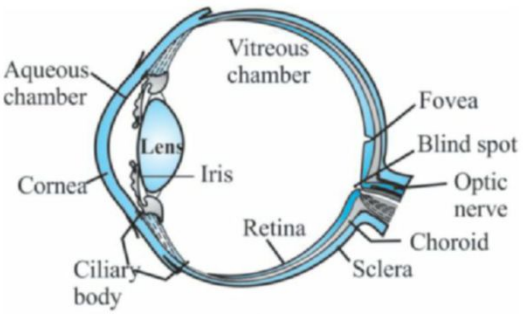


Fig: Diagram showing parts of an eye

Ear:

EAR (Stato-Acoustic Organ) - Organ for hearing and balancing

Ear is anatomically divided into **three** parts - External ear, middle ear and inner ear.

External ear - transfer of sound to the middle ear

Middle ear – transfer of sound to inner ear and amplifying the vibrations of sound

Internal ear – 1. Cochlea for **hearing**

2. Vestibular apparatus for **balancing** (equilibrium)

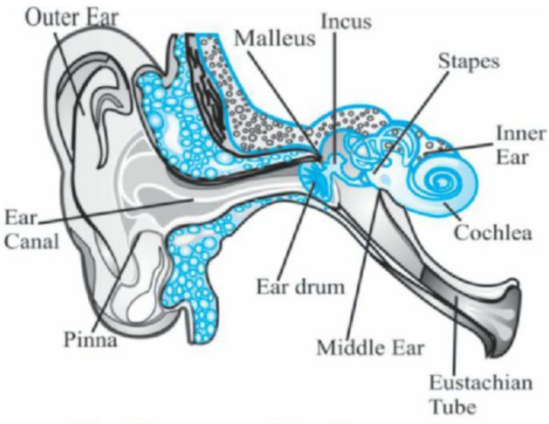


Fig: The parts of the Human Ear

(a) External ear –

i. Pinna (ear lobe)

Projecting elastic cartilage covered with skin. Its outer edge is called helix.

The lobule is lower soft pliable part made up of fibrous and adipose tissue with blood capillaries.

Purpose: Sound collector, Cosmetics

ii. External Auditory Meatus (ear canal)

- Extends from the pinna to the ear drum
- Protects the eardrum
- Contains numerous ceruminous glands (modified sweat glands) which secrete ear wax (cerumen).
- Hairs are present at the opening of ear canal.
- Wax and hairs prevent entry of foreign particles into the ear.
- Wax repels water, traps dust, sand particles, micro-organisms, and other debris.

Wax odour discourages insects.

yellow or brown; others' earwax is dry, crumbly and greyish. Variation at a single gene determines which kind of earwax you have. The allele for wet earwax is dominant over the allele for dry earwax.

iii. Tympanic membrane (Ear drum)

- Ear canal ends in tympanic membrane
- Ear drum is a membrane that separates the external acoustic meatus from the middle ear.
- It is a thin, oval semi-transparent membrane approximately 1 cm in diameter.
- It is covered with thin skin externally and with mucous membrane of the middle ear internally.
- When viewed through an otoscope, the ear drum appears concave toward the external acoustic meatus with a shallow, cone-like central depression.

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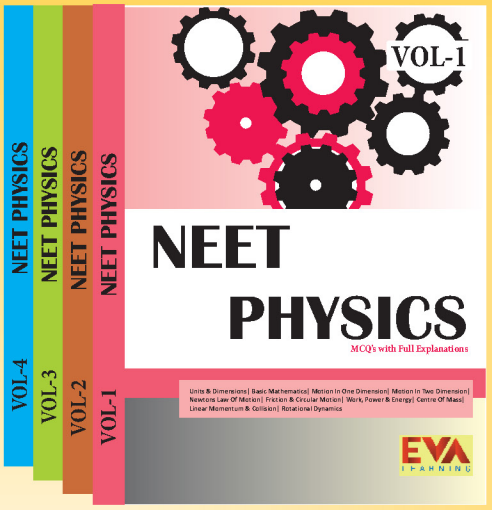

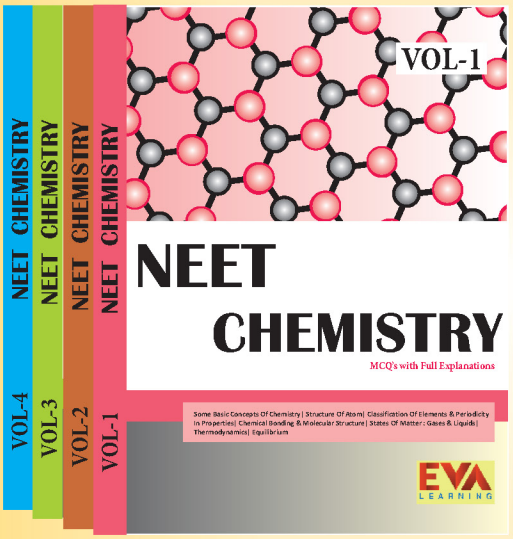

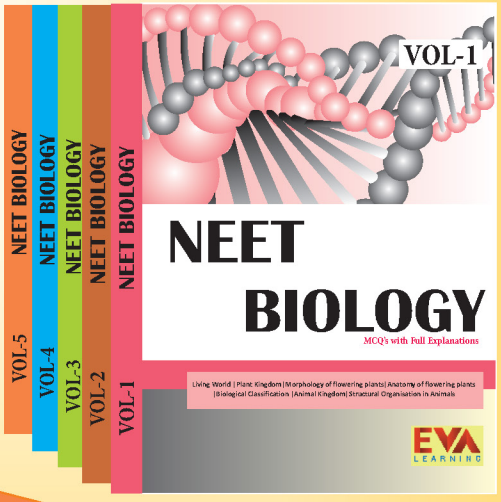

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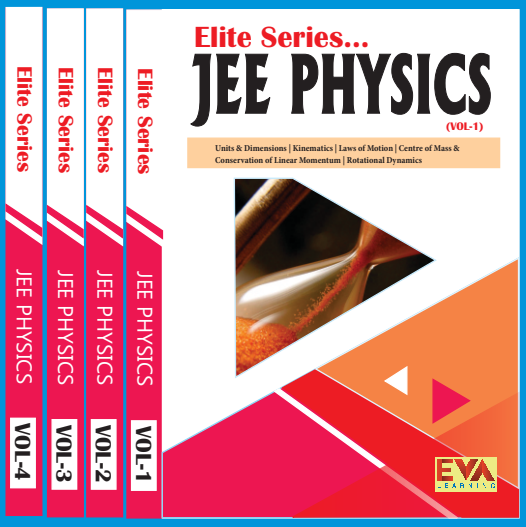

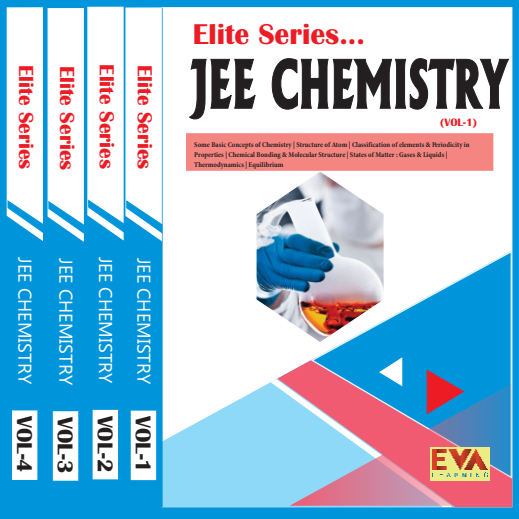

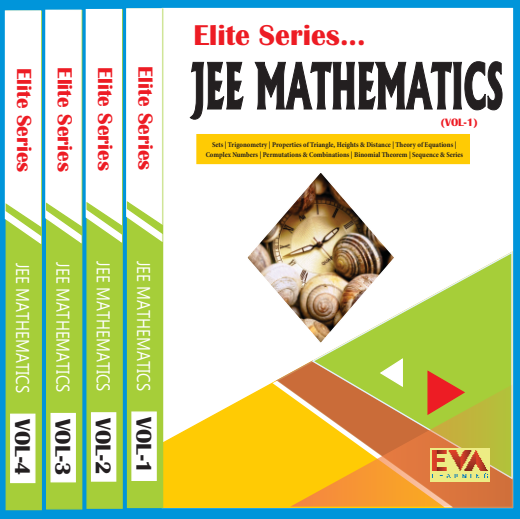

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